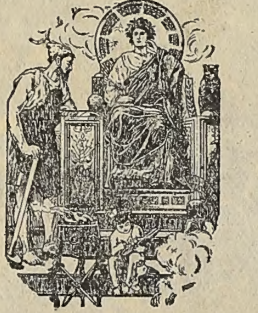

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JANUARY TO DECEMBER, 1905

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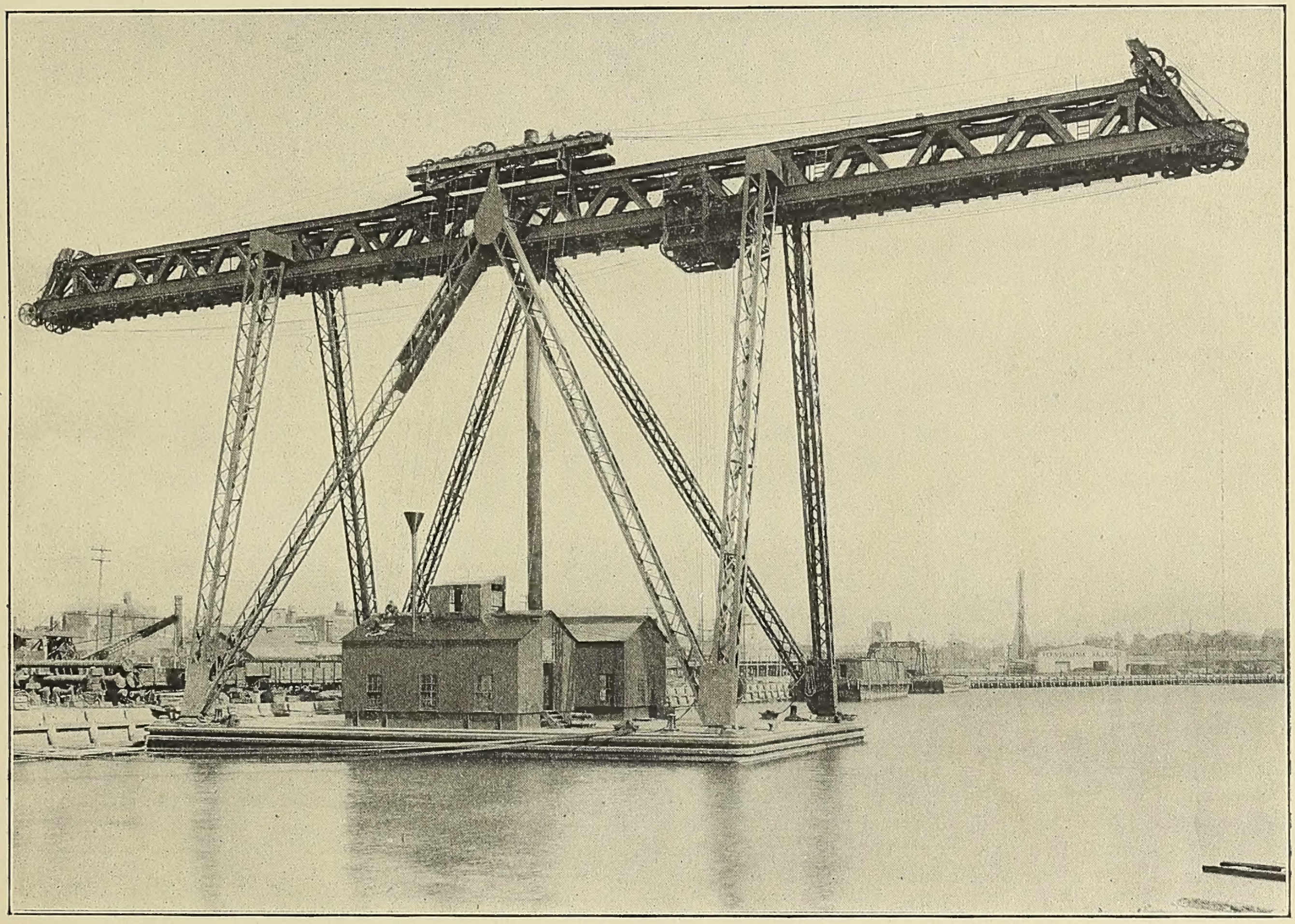
Marine Engineering

Vol. X. JANUARY, 1905. No. 1.

A NEW ONE-HUNDRED-TON FLOATING CRANE.

There is probably no piece of machinery so generally or so frequently used in a shipyard as a crane. From the time of the initial building of the ways and the laying of the keel to the swinging aboard of the last ton of coal for the trial trip, does this instrument of transportation play its important part in the construction of a ship. Its uses are varied and its forms are almost as diverse. A simple mast and jib on the deck of a barge or schooner unloads the material to cars on the wharf; a locomotive crane transfers it from these to the storage racks or piles; one of the traveling bridge type on elevated runways handles it in the work shop for shaping or assembling; and the elaborate cantilever structure mounted on tracks a hundred feet from the ground with booms extended fifty feet on either side, places the finished piece in its destined position on the vessel under construction. These, together with the stationary jib cranes and shear legs located on the wharves, are the kinds most commonly employed on land in shipyard work; but after launching there still remains a large portion of the vessel uncompleted, most of the material for which must be hoisted into place by means of cranes of the floating type.

The mast and jib is one of the earliest of engineering structures, but subsequent development was slow until the general introduction of iron and steel into all construction work, the increased size and weight of machinery, and the tremendous growth of bulky freight transportation, impelled a corresponding elaboration of means for rapid and economical handling. Thus resulted the complex and powerful locomotive and wharf cranes designed by the Germans, the labor-saving interior traveling bridge cranes of the American type, and the recent remarkable floating structures which are a necessity with the present method of finishing the major portion of the construction work on a vessel after it has been launched.



ONE-HUNDRED-TON FLOATING CRANE, FOR THE NEW YORK NAVY YARD, BROOKLYN, N. Y.

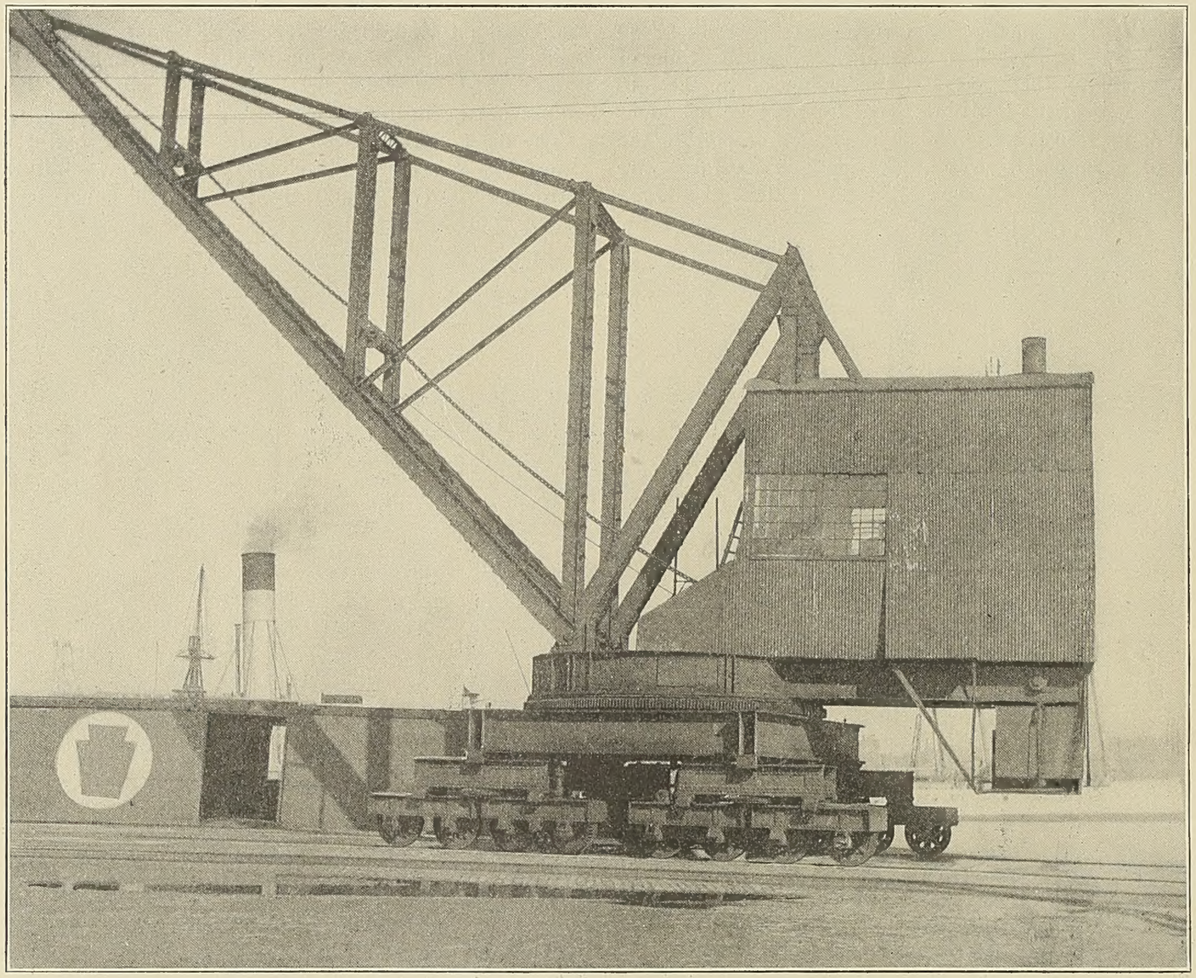
[Photograph by E. Muller.]

But the necessity for a crane of this kind is made absolute in a shipyard where heavy armor-clad war vessels are built and repaired, for only by such means can these operations be successfully carried on.

This latter fact was recognized by congress early in 1896, when the plans for the new navy began to assume tangible shape in the liberal appropriations for new vessels and navy yard improvements. It was not, however, until 1898 that a definite amount of money was set aside to be used for the construction of a steel floating crane of 100 tons capacity—the New York navy yard being designated to receive this machine, for then, as now, this yard did by far the largest amount of repair work and original building.

The pontoon is 60 feet wide, 100 feet long, and 11 feet 3 inches deep, the whole being built of steel plates riveted to steel angles and channels properly braced, and it is divided by water-tight bulkheads into four main separate chambers, viz., two of them midway fore-and-aft, 18 feet long by 30 feet broad by 9 feet deep, for the engines and boilers; one 18 feet broad by 9 feet deep, in section, extending the whole length of the structure for the counter weight, and the remainder merely a water-tight space for buoyancy, which is further subdivided by six longitudinal and six transverse water-tight bulkheads to afford ample protection against sinking in case the hull be pierced through any accident.

In the port side are located two hoisting engines of the horizontal type, with double cylinders 12 inches in diameter and 15-inch stroke, each operating through trains of three cast steel gears, four cable drums 5 feet in diameter, two for the racking or pulling ropes for moving the trolley and two for the hoisting ropes, each separately connected to a hoist block and capable of being operated independently. The drums are of such size as to take the entire length of rope in the grooves cut for this purpose without overwinding; they revolve on forged steel shafts, bronze bushed and provided with compression cup oiling devices; and they are controlled by a system of levers, located on the top of the engine room, by means of foot brakes and a friction clutch on each drum.



FORTY-TON LOCOMOTIVE CRANE, IN USE AT THE NAVY YARD, BROOKLYN

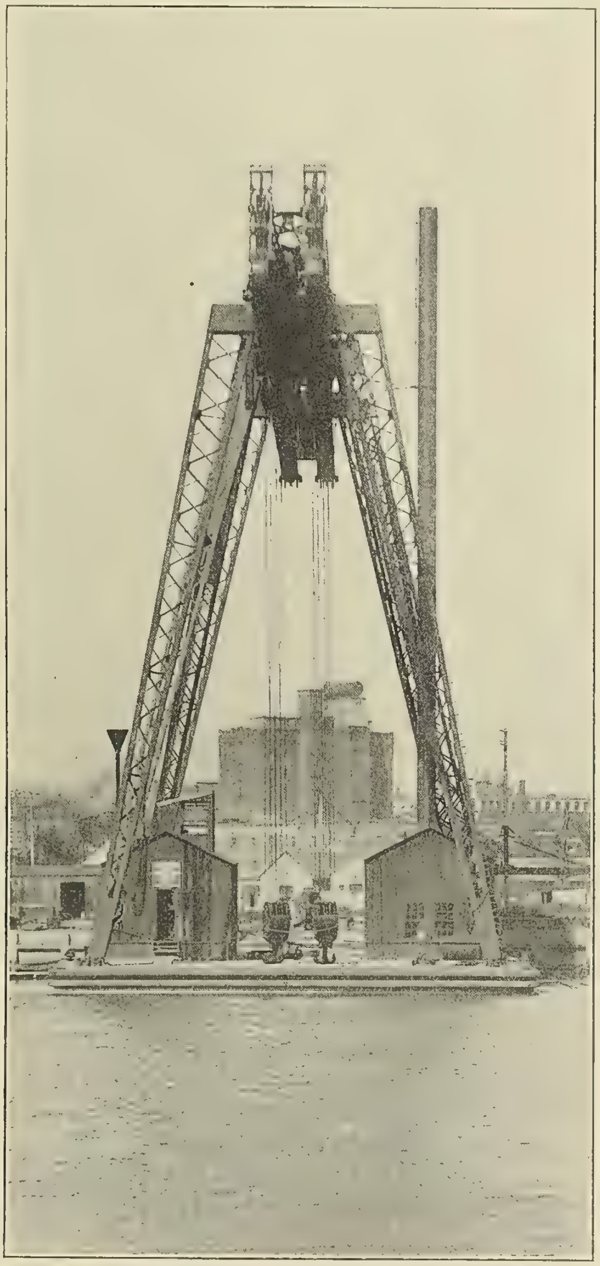
After the preparation of a specification giving minutely the requirements that would have to be met in the design of a crane of this type rather than the details of actual construction, proposals were asked for, and on January 23, 1899, the contract was awarded to the Brown Hoisting Machinery Company on their bid of $100,000. The delivery was to be made on February 12, 1900, but the problems arising as the design progressed were all new ones and were attacked with such thoroughness by the builders that it was not until July, 1903, that the immense structure was finally ready for test. On July 28, 1903, an exhaustive trial was made, under the supervision of Civil Engineer R. C. Hollyday, U. S. N., in charge of the engineering work at this yard, the machine being subjected to lifting, conveying, counterbalancing and manœuvring tests, the results of which were in entire conformance with the specification requirements.

Essentially this crane consists of a rectangular steel pontoon in which are installed the engines, boilers, and counterbalancing device, and the superstructure made up of the bridge for the trolley runway and the supporting struts.

Here is also installed a vertical engine of the double-cylinder type, each cylinder connected through the crank shaft and a steel worm to a bronze worm gear actuating a shaft on which is mounted a cable drum, one for moving the counterweight aft and the other for moving it forward. This engine is controlled by an automatic balanced throttling mechanism operated by a device fastened to a float in a tank at each end of the pontoon, these tanks being filled with water and connected through their bottoms by a pipe of a size sufficient to allow a perfect and rapid circulation from one tank to the other. Thus any deflection of the pontoon will cause a change of level of the water in the tanks, thus moving the floats, which in turn will admit steam to the engine and drive the drums in a direction proper to draw the counterweight in a position to balance the crane. This weight consists of a rectangular box heavy enough to counteract the maximum load lifted by the crane; it is mounted through springs on sixteen chilled faced charcoal iron wheels with double flanges and with axles turning in self-oiling journal boxes. These wheels rest on four lines of 60-pound rails, spaced 2 feet 6 inches on centers and extending the whole length of the pontoon. Independent means for controlling this counterbalancing device from the operating platform are also provided, and in case of any accident breaking either hoisting or trolley ropes, the weight is at once automatically locked in position by a separate control connected to the hoisting and pulling drums. That this counterbalance is effective was shown conclusively in the test referred to previously, when, due to newness, the lifting cables stretched, immediately locking the counterweight. At no time did the deck deflect more than 1 degree and 30 minutes from the horizontal, although 215,000 pounds were lifted and moved from one extreme end of the trolley bridge to the other.

In the starboard side of the pontoon are located two 100-horsepower boilers of the locomotive type, and the necessary boiler feed pumps, injectors, etc.

At each end of the pontoon a laced angle A-frame, pin-connected through a massive casting to the deck, rises vertically to afford support to the portion of the superstructure containing the trolley runway. Additional sustaining power and bracing against wind pressure are secured by means of two similar lateral A-frames riveted to the former at their bases and to the two open trusses of the trolley bridge immediately above the center of the deck. These parallel trusses are spaced 6 feet apart, center to center, are rigidly connected through their top and bottom chords by an elaborate system of bracing, and form on the faces of the two lower chords the requisite support for the lines of 60-pound rails extending the whole length of the structure, and upon which the trolley moves. These trusses are 218 feet 6 inches over all in length, the rails are 78 feet 4 inches above the deck, and the extreme travel of the center of the trolley is 45 feet beyond each end of the pontoon, a total of 190 feet.



END VIEW OF THE NEW ONE-HUNDRED-TON CRANE.

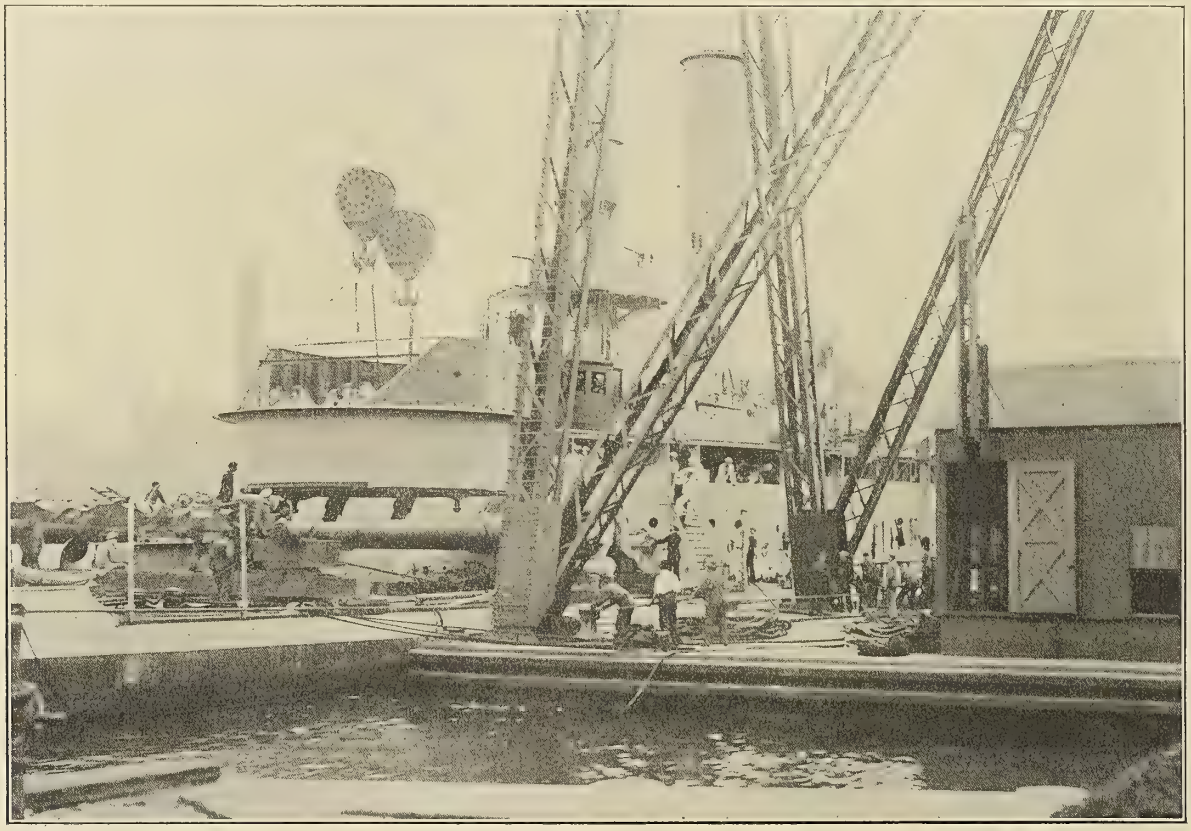
The trolley proper is made up of heavy plates and angles riveted together and hung through pin connections to the four trucks which are each mounted on four charcoal iron wheels, turning in self-aligning, bronze-bushed journal boxes. Within the frame work of this trolley are located twelve steel sheaves 4 feet in diameter, over which passes the hoisting rope sustaining the ponderous blocks for raising the load. Each of these blocks contains four sheaves 4 feet in diameter, so that eight strands of the hoisting rope, which is 1 1-8 inches in diameter, are used to carry the maximum safe weight of 134,400 pounds, for which each block is designed. The double terminal hook forming the attaching device on each block is of steel 9 square inches in section, and the weight hanging thereon is transferred to the block through specially hardened steel ball bearings having two circles of contact. The hoisting mechanism was purposely constructed in two separate parts, independently controlled, for thus can two connections be made to a large, heavy piece of material such as a turret, a 13-inch gun, or an engine, and the level governed with absolute accuracy when lowering into position. This feature is of great importance, for in this manner entire contact is made simultaneously in cases where a line or a point contact would ruin the piece being handled.

As above stated, the limit of horizontal travel of these blocks is 190 feet, and they are capable of being raised 64 feet above the deck and 22 feet below it. The speed is 54 feet per minute for vertical hoist and 106 feet for horizontal travel. The racking and lifting ropes are of the best plough steel wire, 1 1-8 inches in diameter, the ends of the latter being secured at either extremity of the trolley bridge to an equalizing device. There are in all 5,565 feet of this rope, guided on the crane by 48 steel sheaves 4 feet in diameter, practically all of which is in use when the blocks are in their lowest possible position with the trolley at the end of the bridge.

In addition to the maximum load on the hoisting mechanism, there can be simultaneously borne on the deck a weight of 300 gross tons with 2 feet freeboard, which thus allows a large amount of material to be removed from a vessel and stored on the deck prior to final transportation to the shops and storehouse. The total weight of the crane itself, which is of open hearth steel throughout except doors, windows, and the fender strips, is 2,656,000 pounds.

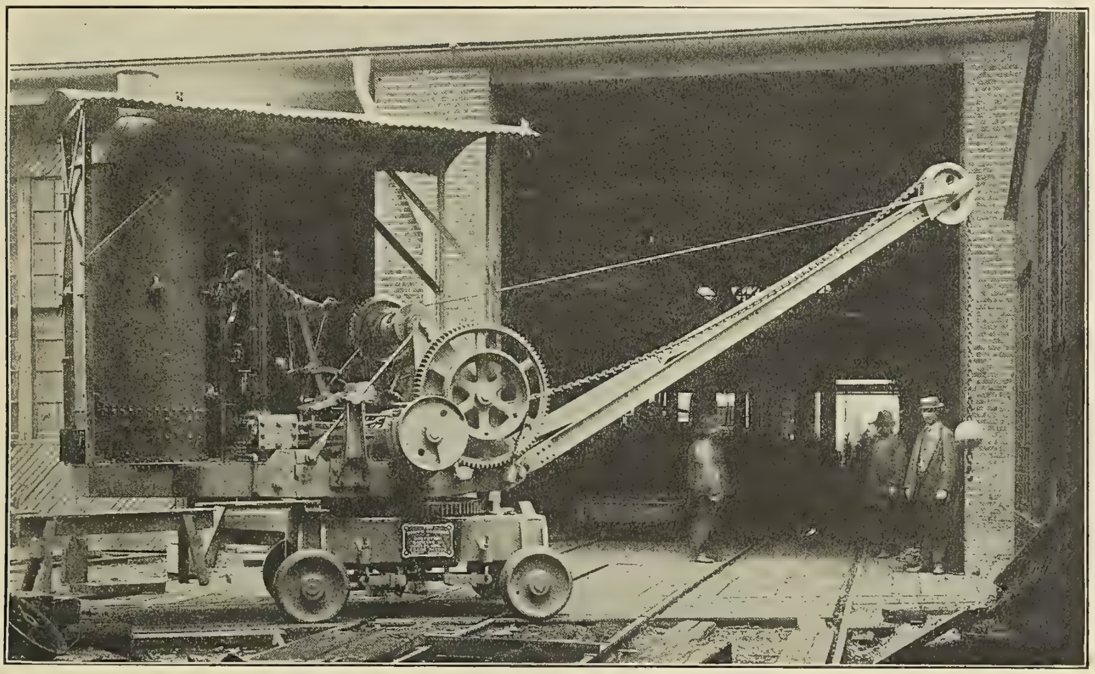
It was originally contemplated to equip this machine with propellers so as to make it an absolutely self-contained structure, but this was found to be wholly impracticable owing to the immense size; and removal from place to place is now done by tugs and the final warping into proper position by four winches, one at each corner, driven by a 5-inch by 8-inch double cylinder steam engine secured to the under side of the deck.

Even the projectors of this crane could not foresee the great usefulness of a machine of this character; and it has been found perfectly adapted to the diverse kinds of work on which it has been used during the fifteen months. Originally intended for handling heavy and bulky vessels' equipment, the requirements in this regard have been more than met; for with it immediately upon acceptance, the great armored turret of the U. S. monitor *Florida*, which weighed 120 gross tons, was successfully removed and replaced, and since then the turrets and heavy guns of the battleships *Iowa* and *Indiana* have been handled equally as well. The most interesting confirmation, however, of its ready and economical adaptability to this class of work was seen recently when it was taken to Jersey City and used to unload a new 13-inch gun from the specially designed railroad car to its deck, where it was conveyed back to the navy yard. Here, after removing a defective gun, the crane placed the new one in the turret of Admiral Evans' former flagship, the *Kentucky*, with absolute precision and without the slightest accident. To do this work a private concern asked a compensation of $4,000; the saving is astonishing, for the amount actually expended was less than $200. The economy resulting from its use is not alone confined to operations such as these, for in the building of a new



REMOVING THE TURRET OF THE UNITED STATES MONITOR FLORIDA, AT THE NAVY YARD, BROOKLYN, N. Y.

pier at the New York yard from a large quantity of immense granite blocks formerly used for quay-wall construction and which had to be resurfaced, this crane was utilized. An air compressor was installed next to the engine room and a large pneumatic surfacing machine was placed on rails on the deck of the pontoon. The hoists furnished ready means for the required handling of the granite and the dressing was carried on simultaneously with the other work in which this crane was engaged. Another very important case in which this giant machine proved to be extremely useful was in the removal of an old granite and concrete quay wall on pile foundations which extended across the ways on which the U. S. S. *Connecticut* was building. By this means the masonry portion was taken out in large pieces and the piles were then removed whole without injury. At this time an incidental demonstration was made by displacement observations that the resistance to upward pulling in piles varies from 50 to 75 tons per pile in ordinary soil, which data are very valuable in connection with the design of dry docks where there is an immense upward pressure due to buoyancy to be overcome when the dock is empty.



TEN-TON LOCOMOTIVE CRANE AT THE BOSTON NAVY YARD.

An additional fact regarding this crane is appropos here and will probably further confirm the admirable foresight of the naval engineers who urged its construction. Early in 1903, when war clouds were descending rather thickly in Asia, and Europe as well, and when this crane was about ready to be turned over to the government, a representative of a foreign state, duly accredited for the purpose, offered $250,000 for this machine, which tender was, of course, refused. The wide range of usefulness of this absolutely unique structure, in point of both size and design, was thus reserved for the navy of the United States, where its importance will grow as the plans for our new navy mature, and where, if war occurs, it will prove one of the most valuable adjuncts in the repair and equipment of our naval vessels.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 83 sail and steam vessels, of 20,282 gross tons, built in the United States and officially numbered during the month of November, 1904, as follows: 37 sailing wooden vessels, of 16,859 tons; 40 wooden steam vessels, of 1,680 tons; one steel sail vessel, of 331 tons; and five steel steam vessels, of 1,412 tons.

IN THE ENGINE ROOM OF THE STEAMER TURBINIA.

BY MORRIS M. WHITAKER.

The writer had the opportunity some few weeks ago of inspecting the first turbine-driven vessel in commercial use in this hemisphere, on her daily run between Toronto and Hamilton, Canada, and was able, through the courtesy of the owners, to obtain particulars which may be of interest to the readers of Marine Engineering. The *Turbinia*, built by Hawthorn, Leslie & Company, and engined by the Parsons Marine Steam Turbine Company, has fulfilled her owners' expectations by a very successful season. The passenger and freight traffic between Hamilton and Toronto during the summer season is very large, and up to the advent of *Turbinia* had been divided between the railways and a line operating two steamers of about 14 miles speed, with the latter carrying the bulk of the traffic.

Some enterprising gentlemen of Hamilton determined to enter this field, and with characteristic energy and forethought decided to take advantage of modern progress in marine engineering and use the turbine principle. They accordingly placed an order with Parsons about the last of December, 1903, and with the opening of the season of 1904, the *Turbinia* was making her bid for popular favor. Her speed, steadiness, absolute regularity of service, and, possibly, novelty, have made her a favorite with the public; while her economy in running expenses, such as attendance, coal, oil, etc., have proved her a success from the owners' standpoint. As she is fully equipped for use in salt water, it is the intention of the owners to fill in the closed season on Lake Ontario by running her between Nassau and some Florida port, thus having practically no break in her earning capacity.

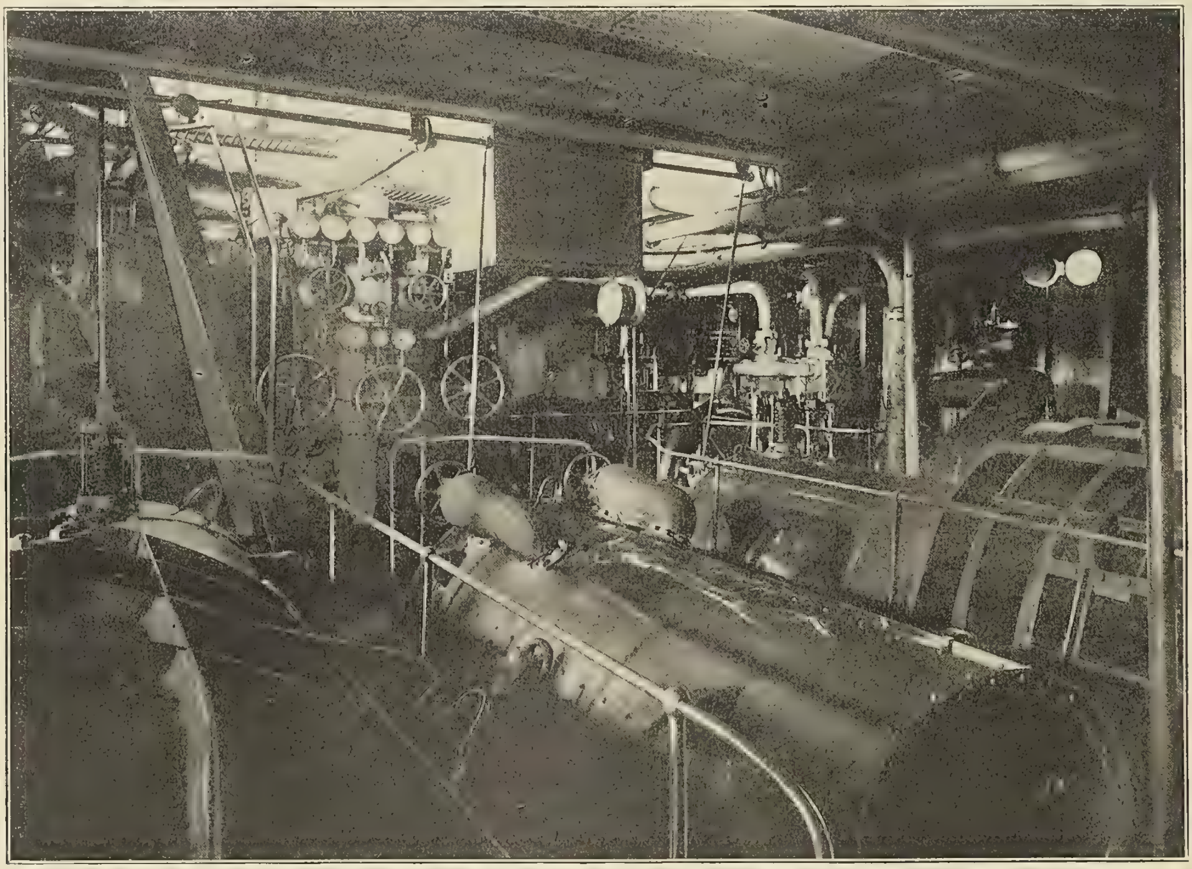
The theory of the turbine has become fairly familiar nowadays, but very little has been published giving information from those who have had close practical experience with the new system of using steam, and accordingly I will try to give some account of it as gathered from the engineers in charge of *Turbinia's* machinery, and personal impressions from watching it in operation.

After her trials on the Tyne, the vessel started across the ocean, and, although she had a very rough passage, the run from Stornaway to Sydney, Cape Breton, was made in six days, at the rate of 17 1-2 knots, head seas being the rule rather than the exception. Although *Turbinia* has very fine ends and pitched a good deal, the governors never came into action, even though they were set at only 40 revolutions above the normal. Her coal capacity in bunkers is 110 tons, and for the trip 500 tons additional were taken aboard, and yet, on her arrival at Sydney, she had over a day's supply still on hand, which is very good considering her rough trip and that she was not eased off on account of the weather. I believe she is the first turbine-propelled commercial vessel to cross the ocean.

As is usual, the propelling machinery consists of a high-pressure turbine placed on the center shaft and two low-pressure turbines placed in the wings, each exhausting into its own condenser. The circulating and air pumps are in duplicate, as are the feed pumps and the oil circulating pumps for the bearings on the turbines. The arrangement of the machinery is shown below, and occupies a fore-and-aft space of about 30 feet.

The attention required by the engine-room force after once starting is very small, and most of this is devoted to the auxiliary machinery. The watch consists of one engineer, one oiler and water tender, three firemen, and one coal passer, to take care of machinery of 3,400 estimated horse power and all the auxiliaries. The oil placed in the oiling system when she was tried on the Tyne is still being used, and the main engines have never been even opened out for examination, nor has any adjustment been made during the season. It is a pleasure to watch the manœuvring possible with this type of machinery, and how beautifully it is made to respond to orders from the deck. In starting and coming into the dock two of the engine-room force are stationed at the three operating wheels shown in the cut of the engine room. The center wheel controls the admission of steam to the high-pressure turbine (which is used only when going ahead and not in manœuvring) and those to starboard and port the admission to the wing turbines. By turning these wheels to right or left, steam is admitted directly to either the go-ahead or backing ends. The control is practically instantaneous, and so smooth and vibrationless that if one did not watch the governor balls on the forward ends of the turbines and hear the rush of the steam in the main steam pipes, he would not be aware of any movement. The slow, half, or full-speed, ahead or astern, are given by the amount of steam admitted, and can be regulated by the steam gauges directly in front of the operator.

When the boat is once clear of the dock and on her course, the valve to the high-pressure is opened and those controlling the admission into the wing turbines are closed, and the steam takes its course through the high-pressure center turbine to the low-pressure wing turbines. When running throttled down there is considerable noise due to the rush of steam through the throttle, but when the valves are full open this is not noticed and there remains only the roar of the auxiliary machinery. Amidships no vibration is perceptible; but at bow and stern, and especially the latter, considerable vibration is felt, which is doubtless due to the propellers. If the auxiliaries were run on the turbine principle, a person standing amidships would hardly know any machinery was in motion. When running at full speed *Turbinia*, due to her beautiful model, makes no more fuss than many boats of similar size at half the speed.



ENGINE ROOM OF THE CANADIAN TURBINE STEAMER TURBINIA, LOOKING FORWARD.

The following are particulars of trial on Lake Ontario shortly after arrival:

Boiler pressure ....160 lbs.
High-pressure turbine ....122 lbs.
Low-pressure turbine .... 45 lbs.
Vacuum ....27 1-2 ins.
Revolutions center turbine.........................650
Revolutions wing turbines..........................717
Speed, 31 1-2 miles (5,280 ft.) in 1 hr. 20 minutes.
Coal per hour 2 2-10 tons or 1.46 lbs. per I. H. P. per hour.
Feed temperature ....178 degrees
Evaporation, 8 lbs. water per lb. coal.

On regular runs boiler pressure is maintained at about 135 pounds, steam at high pressure 90 pounds, low pressure 32 pounds, vacuum 27 inches, revolutions center turbine 550 to 575, wings, 600, speed 31 1-2 miles 1 hour 25 minutes to 1 1-2 hour.

The high-pressure turbine on the center shaft turns right-handed, and is fitted with seven steps of blades with from 5 to 7 rows each. The diameter of the turbine is 40 inches, and that of the outside casing 48 inches; the length is 8 feet 6 inches. The two low-pressure turbines, one on each wing shaft, have five steps of blades and are 48 inches diameter, outside of casing 56 inches. The length of the turbine is 11 feet, which is made up of 5 feet 6 inches for the go-ahead machine and 5 feet 6 inches for the backing turbine; thus there is a backing turbine in the casing of each low-pressure turbine. The blades vary in length from 1 1-4 to 6 inches and have a clearance of 1-32 inch. The governors and collar thrusts are placed at the forward ends of shafts. All shafting is 5 1-2 inches diameter. The propellers are solid bronze, elliptical shape, true screw blades, 49 inches diameter and 44 inches pitch.

The weights of machinery are as follows: Each of the two boilers, with water, 70 tons; the three turbines and shafting 58 tons; the auxiliary machinery 5 tons. Each low-pressure turbine exhausts to a condenser next to the skin of the ship and each condenser has its set of air and circulating pumps, which are driven by a pair of reciprocating engines 9 by 7 inches, running at a speed of 200 revolutions per minute. The circulating pump is placed at the forward end and the air at the after end. The feed pumps are in duplicate and of the long stroke, slow-moving, Woodson type, 28 strokes per minute. A pressure of 5 pounds is maintained in the oiling system by two Weir pumps.

Air pressure on the closed stoke-hold system is maintained in the fire room by a double-acting, high-speed blower engine, direct connected to fan. The ship is lighted throughout by electricity by means of a direct-connected generating set.

MARINE ENGINEERING DATA CARD. JANUARY, 1905.

NAME—Turbinia. NATIONALITY—Canadian. TYPE—Lake passenger steamer.

LAUNCHED—1904. BUILDERS { Hull and Boilers—Hawthorn, Leslie and Company. Turbines—Parsons Marine Steam Turbine Company.

Length over all	260 ft. 0 ins.
" between perps.	250 " 0 "
Breadth, molded	32 " 6 "
Load draft, mean	9 " 0 "
Load, displacement	1100 tons
Block coef.	.53
Engines:	Parsons turbines
One high press., on center shaft turn right hand.	
Two low press., on 2 wing shafts turn right and left.	
Expansions, total number	127
Horse power, estimated	3,400
Shafting, main and tail, 5 1-2 ins. diam	
Propellers:	
Solid bronze casting.	
True screw.	
Diameter	49 ins.
Pitch	44 "
Boilers:	
Two single end Scotch.	
Length	10 ft. 6 ins.
Diameter	17 " 6 "
Pressure, gauge	160 lbs.
Furnaces: each	4 Morison
Diameter	42 ins.
H. S.	6,688 sq. ft.
G. S.	182 "
Draft; forced, closed stoke hold.	
H. S. ÷ I. H. P. (estimated)	1.97
H. S. ÷ G. S.	36.7
I. H. P. (estimated) ÷ G. S.	18.7

Florida Motor Boat Carnival and Races.—The first annual motor boat and water carnival at Palm Beach, Fla., will take place February 1 to 3 inclusive. It is proposed to give four races each day. The races will take place on Lake Worht, a fine sheet of water, and it is hoped that many of the representative builders and owners will enter boats for this event, which is under the Palm Beach Power Boat Association.

PRODUCER GAS ENGINES ON SHIPBOARD.

BY BERNHARD A. SINN.

The engine room equipment of a vessel propelled by gas is much the same as that of steamships. The machinery of steam vessels may be divided into two general subdivisions: the driving engines and the auxiliaries. The latter may be subdivided into four classes: those auxiliary engines necessary for the proper operation of the main engines, those required for the boiler room equipment, such machinery as is needed to keep the vessel itself in good running order and to assist the loading and discharging of the same, and, lastly, those required for the convenience of the passengers and crew.

In the operation of the main engine's condensers, air, and circulating pumps, water and oil circulating pumps are necessary.

For the proper operation of the boilers, feed pumps, distillers, evaporators, blowers and fans, ash ejectors, superheaters, feed heaters, injectors, etc., are needed.

For the proper operation of the vessel itself we must have windlass, steering gear, bilge, ballast and fire pumps, and where cargo is carried, winches and other deck machinery. Those carrying dressed beef, fruits, etc., must have a large refrigerating plant.

For the convenience of the passengers and crew electric light machinery, heating and ventilating systems, sanitary and fresh water pumps, distilling apparatus and hot water supply are required.

In a vessel propelled by gas the latter two subdivisions are necessary in all their details, and in place of the first and second, other machinery has to be installed to accomplish such purposes a the requirements may call for.

A gas propelled vessel requires in addition to the main driving engines exhausters for the gas producers; an air compressing plant to reverse the main engines, operate other engine gear, and to blow the whistle; circulating pumps for circulating water through the main engines and to give water to the steamer of the producers; and other auxiliaries not directly used for the propelling engines, such as re-heaters for heating and sanitary purposes. In other words, the amount of auxiliary machinery necessary in a gas propelled vessel is no greater than that in steam vessels and much less complicated.

The manufacturers of pumps are now supplying electrically driven pumps which have a high efficiency as far as power is concerned, and are very much more economical than direct driven steam pumps, and as it is a well known fact that the modern steam pump is a most uneconomical piece of mechanism, it is possible to generate auxiliary power cheaper with producer gas and gas engines and supply electric power from this source than would be the cost of running auxiliaries by steam direct.

Where a gas producer plant is already installed on board ship, a direct driven electric plant of sufficient size to furnish power for the auxiliary machines and to do other work should be installed. The compressed air is furnished by a small electrically driven air compressor for the start, and, if desired, from the main engines when running. These machines are now built so that the power is regulated by the pressure and practically a constant air supply is furnished.

It is unfortunate that the high price of liquid fuel has prevented the adoption of gas engines for large powers on board ship. Although in recent years some vessels of considerable tonnage have been equipped with oil engines and proven very successful, the main objection to oil engines heretofore has been, firstly, the higher insurance rate demanded, owing to the popular belief that oil fuel is dangerous to handle, and, secondly, the non-reversible properties of the engine. In order to drive the vessel astern it is customary to use a combination of heavy gearing which will give opposite motion to the shaft and propeller. This is not objectionable for small powers, but it is manifestly impracticable to design a reverse gear to transmit large powers. If it were possible to design a gear that would reverse an engine of 5,000 I. H. P. having an 18-inch crank shaft, it would require gears of 12 feet diameter and 4 feet face. There is in addition always the danger of a breakdown in the reverse gears through defective teeth and castings and slipping of the clutches and dogs.

Manufacturers of marine gas engines in the last two years are, however, building engines that may be reversed by compressed air. This is accomplished by cutting off the gas, turning the cam shaft 90 degrees, and sending compressed air into the cylinder when the change in the time of admission and exhaust is sufficient to catch the engine in the reverse motion in one of the three cylinders and reverse the same. As soon as the engine is started in the opposite direction gas is admitted through the proper valves, the time of ignition arranged to suit, and the engine operated in the reverse direction in the same manner as previously in the go-ahead motion. All this is accomplished with one lever and valve, the lever operating the cam and ignition shafts, and both of the compressed air and gas valves.

Although no engines of considerable size have been installed aboard ship owing to the high price fuel, as before mentioned, the introduction of the gas producer will soon compel progressive vessel owners to give the matter deep thought. It is therefore necessary to turn to land practice for such information regarding gas engines in order to speak intelligently on the subject. Both in this country and abroad vertical gas engines of 3,000 to 5,000 horse power have been successfully installed for the production of electric and other power. These engines have all the requisites of a marine engine excepting reversibility, and this point can be readily taken care of as before mentioned. This is a good starting point for the designer of marine gas engines, as there is a definite piece of mechanism from which to draw. Manufacturers of large gas engines on land are building double-acting engines of both the four and two-cycle types.

For small powers a two-cycle engine is preferable in a great many cases, owing to its light weight and the fact that it can be reversed by hand, whereas a four-cycle engine cannot; but in large powers, particularly on shipboard, where space is a great consideration, the lack of economy of the two-cycle engine and its very much increased height, would be more than sufficient to offset the increased weight of the four-cycle type. Taking these things into consideration, it is certain that the four-cycle engine, as it is being built to-day in large powers, is the more desirable type and can be safely recommended for marine purposes. A three-cylinder, double-acting, four-cycle engine gives six explosions in each two revolutions, which is the same as a two-cycle, single-acting engine.

In the best gas engine practice the following proportions are generally adopted:

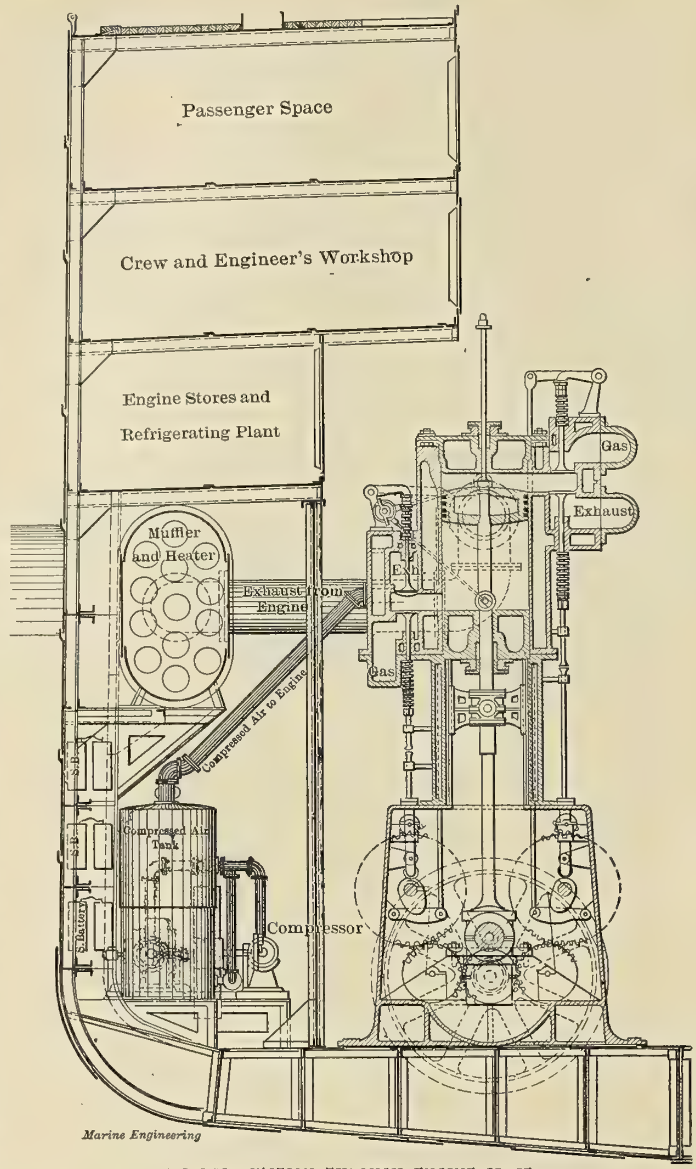
With producer gas and a well-designed engine operating on a high compression, 85 cubic feet of gas will prove sufficient for one indicated horse power. A piston speed of about 800 feet per minute is as high as has yet been attempted, and a mean effective pressure per explosion of 70 pounds is generally obtained in good practice, although as high as 80 pounds per square inch has been shown. These considerations determine the size of the engine cylinders.

The speed of 100 feet per second for inlet and 85 feet per second for the exhaust gases are generally accepted figures. It is necessary therefore to design the valves and ports of such areas as will admit and exhaust the gases at these speeds. The valves should have an area of 15 to 20 per cent. of the cylinder area, and should give a quick opening and extremely rapid close. With producer gas a mixture of about equal quantities of air and gas gives the total volume of mixture necessary, and with these proportions the valves may be readily designed of proper size.

The compression space for a compression of 150 pounds per square inch should be 1-4 the volume of the piston displacement, and the height of the compression space 5-8 the diameter of the inlet valve.

With a double-acting engine, piston and connecting rods are necessary; in single-acting engines the piston rods may be dispensed with.

The cam shafts and ignition shafts are directly operated by



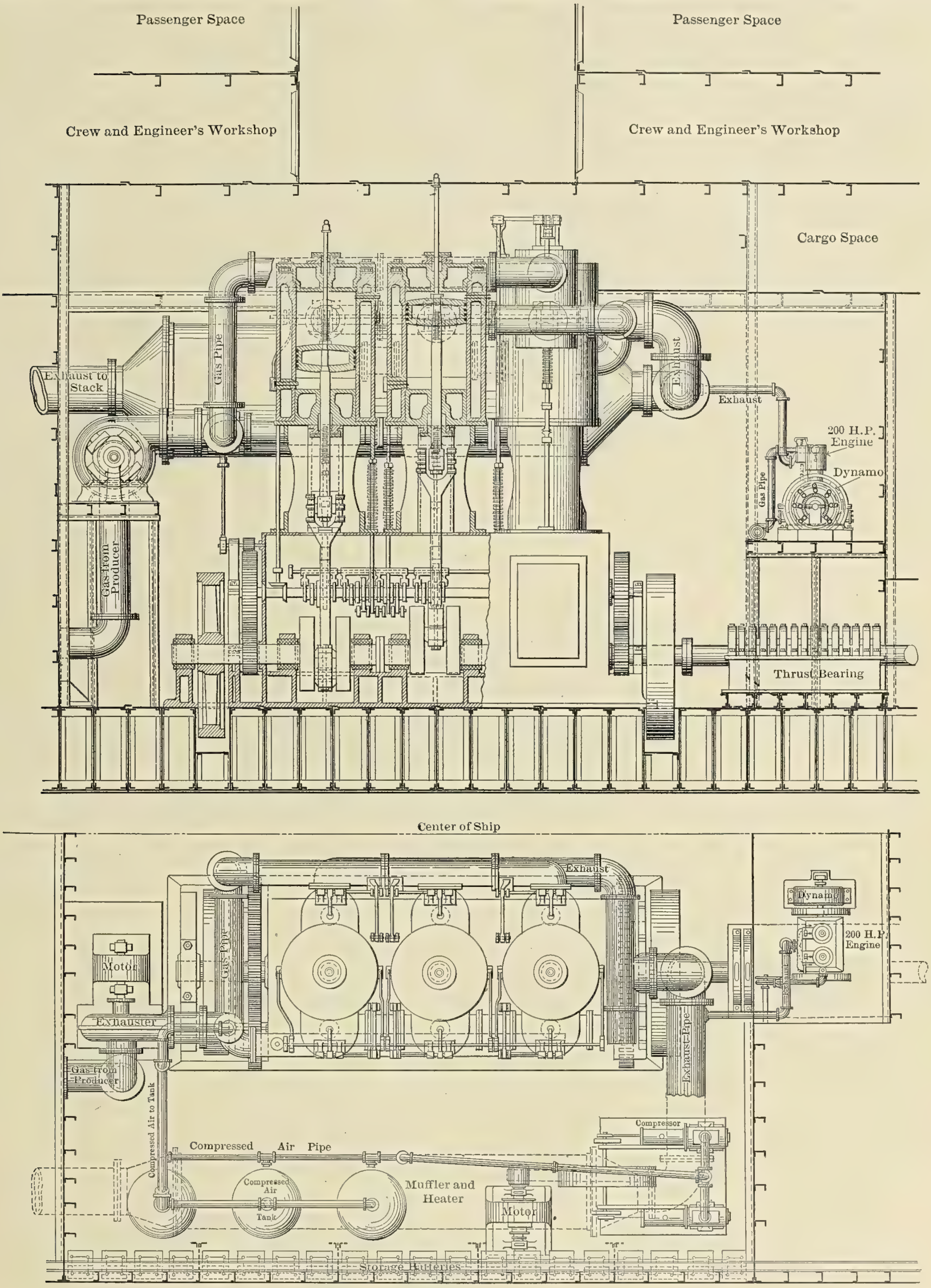
MIDSHIP SECTION THROUGH ENGINE SPACE.

gearing from the main shaft and the cams are designed to give the proper lift of the valve at the proper time. For each valve there will be three cams—one for operating the valve when the engine is going ahead, one for operating the valve when the engine is being reversed, and the third for operating the valve while the engine is going astern. This is accomplished by making the cams movable on the cam shaft and by means of forked levers pushing them forward and backward on the shaft. A small air cylinder and rack will do this, and a locking device is added for permanence in either the ahead or astern motion.

The ignition is timed by means of a counter shaft, with the usual make-and-break hammer spark arrangement; this counter shaft is operated by gearing from the cam shaft. When the cams move horizontally while the engine is being reversed, the time of ignition is changed at the same time by twisting the shaft through the proper arc and thus changing the time of spark.

The bearings, connecting rod, crank shaft, piston rods, slippers, guides, cross heads, etc., are all of the same type as in a steam engine of equivalent size. The piston is somewhat different, generally convex on top and bottom and hollow, and is ground into the cylinder. The piston and tail rod stuffing boxes are exceptionally deep and have very heavy packings, to prevent them blowing out from the high compression and explosive pressure of the engine, and to prevent leaking in any way whatsoever.

The cylinders, ports, valve chests, exhaust valves, as well as the



ELEVATION AND HALF-PLAN OF ENGINE ROOM, WITH TWO 5,000-HORSE-POWER GAS TURBINES FOR USING PRODUCER GAS.

pistons, tail rods, and connecting rods, are water cooled, the water being supplied by means of an independent circulating pump or a direct driven circulating pump from the engine itself.

The materials used in the construction of an engine of this type must be of the very strongest and best; cast steel is preferable in all castings excepting the cylinders, which should be of very fine, close grain iron; the valves should be of steel ground into place, the valve stems, tail rods, and piston and crank shaft of the very finest quality of forged steel hollowed where possible to lighten weight. The valves should be all operated by direct springs, which must be kept constantly oiled and should be incased to prevent dirt and dust getting into them. Mufflers should be placed around all openings from the cylinder that would be likely to transmit sound, and cases should also be placed over all ignition plugs and heads. These cases should be made in tin lined with asbestos or other non-conducting material.

The gases after being burned in the cylinder of the engines are led to a muffler where the sound of explosion is reduced to a minimum and the heat in the exhaust gases utilized for raising the temperature of water for hot water and heating purposes; in this way such heat as is required for the vessel is procured from the exhaust at practically no cost, the gases being led to the stack after their passage through the muffler. When the engines are not running gas may be directly burned under the heater or muffler and the water heated by this means. An independent pump supplies such water as is necessary, and still further economy is obtained by using the jacket water of the engines—which is also used in the gas generators for steam purposes.

The compressed air plant is necessary for reversing the engine and blowing the whistle. It consists of two independent units storing air in tanks at a high pressure and then piped to the reversing valve and whistle. This air compressor is operated by a motor and can be run at a low or high speed, as desired, and may be so arranged that the motor is started or stopped electrically from the pressure gauge.

The most important auxiliary plant in a gas propelled vessel is the electric plant, which must be capable of doing a large variety of things. As soon as the starting producer is supplying gas the electric plant is ready for operation. It must store up energy in the accumulators; be ready to operate such pumps as require to be used; drive the blowers for starting the main generators, and also the exhausters for supplying gas to the main engines; it must run the various small pumps throughout the vessel, the deck machinery, steering gear and windlass, and supply light as needed, and supply the ignition spark for the engines. For this purpose in the illustration there are shown two plants each of 150 Kw., capable of being overloaded 50 per cent., and this 300 Kw. in addition to such excess as may be derived from the storage batteries, will be sufficient to operate the full auxiliaries of the vessel. The dynamos are connected to the gas engines and the piping so arranged that the gas engines may take gas either from the starting machines or from the main producers. As the storage batteries also are connected to the main switchboard the motors may be operated from generators or from storage batteries.

The main and other engines should be supplied with oil from tanks with automatic filling devices, and means for re-using the oil in the crank pit, etc., should not be neglected.

The two main driving engines with their thrust bearings, as is customary in twin-screw vessels, occupy the center of the engine room space. On each side on the floor are air compressors and tanks and such pumps as are necessary. On platforms built at the forward end of the engine room are the exhausters which suck the gas from the gas generators and deliver the same to the engine. On a platform at the atfer end of the engine room are the dynamos. Above the hold stringer on each side are the mufflers and hot water heaters, and in the lower 'tween decks the refrigerating plant, machine shop and other small auxiliaries. The storage batteries are placed well out at the side between the frames and on the stringers. The blowers for starting the generators are also situated in the engine room.

The piping is so arranged as to be easy of access, and one noticeable feature is the absence of all the small steam piping that is so difficult to place in steam vessels; in place of this there are only the electric wires and the main gas, air, and exhaust pipes, the auxiliary gas pipe to the electric generating sets, and the piping from the air compressor plants.

This description will in general describe the requirements of a gas propelled vessel; it is difficult at the present moment to say what means will be employed for accomplishing these different results, but no doubt very little radical departure from present methods will be utilized for some time to come.

In the comparison of steam and gas the three things which must be taken into consideration are, first, cost of operation; in this may be included first cost in the form of interest, depreciation, and insurance; second, weight of machinery and accessories; and, last, the space occupied. The value of a vessel is its earning capacity, and this must not be sacrificed in any form unless the cost of operation and management would far outweigh these considerations.

If the machinery of a steam vessel of size such as has been employed for comparison in this article is divided into groups, the first group containing boiler room equipment, the second the engine room equipment, the third the auxiliary machinery, and the fourth fuel and water, and a comparison made with the gas propelled vessel, it will be found that there is very considerable difference in weight, group for group. The boiler room equipment of a steamer weighs more than the producer room apparatus on a gas propelled vessel; the gas engines, however, are somewhat heavier than the steam engines would be, but if the necessary bunker coal and water in both vessels be taken into this comparison it is apparent that the economy in coal consumption more than balances any consideration of weight in the machinery itself. As the thwartship bunkers may be dispensed with, the total length of the engine and boiler space is eight frame spaces less in the gas propelled vessel than in the steamer, and this twenty feet thrown into cargo space gives just sufficient cubic capacity to stow the additional cargo that may be carried, owing to the decreased weight in machinery and bunker coal.

In the small tabulated statement a comparison of costs and weights for a 10,000 I. H. P. plant is made, and a decided saving in first cost, in operating expenses, in space, in weight, and an increase in carrying capacity and a large increase in earning capacity are shown, so that the future of gas propelled vessels is assured as soon as engine builders shall supply proper machines.

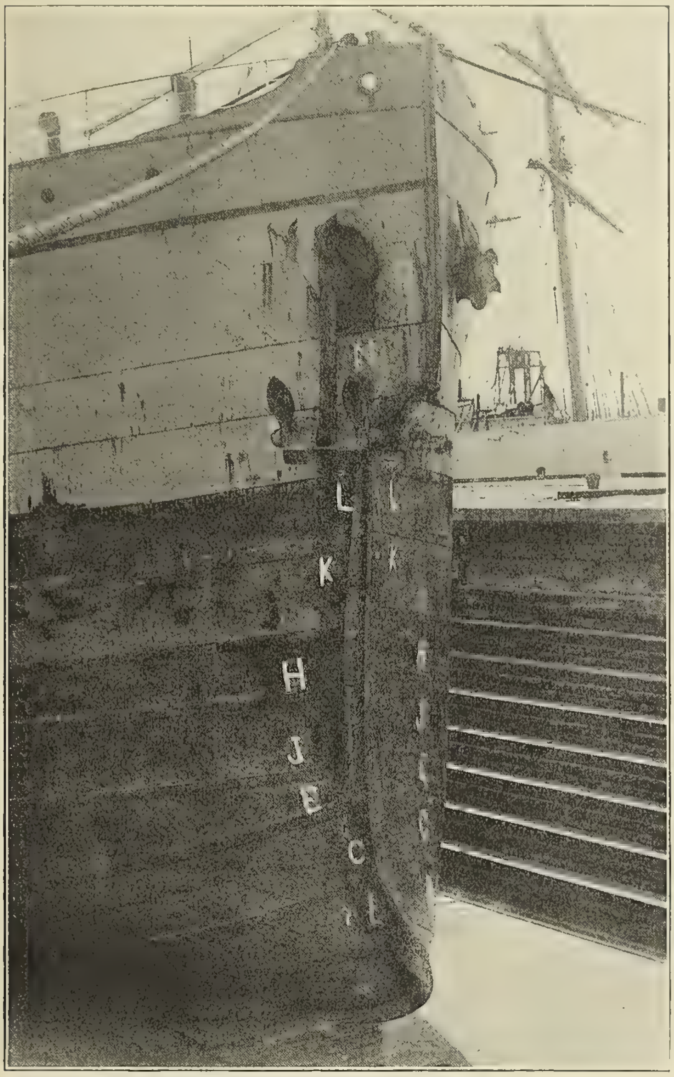
WEIGHTS FOR 10,000 I. H. P. MARINE ENGINES.

Steam Power Vessels.	Tons.	*Gas Power Vessels.*	Tons.
Main engines	385	Main engines	465
Condensers	56	Heaters and mufflers	32
Boilers	315	Generators	165
Uptakes, stacks, etc	86	Relief and exhaust pipes	38
Fans, feed heaters, etc	41	Exhausters and blowers	36
Pumps and auxiliaries	19	Compressor air plant, pumps, etc.	66
Electric light plant	20	Electric plant	40
Spares and sundries	15	Spares and sundries	18
Donkey boiler, complete	32	Starting machines	22
Water in boilers	180	Water in generators, etc	45
Total	1,149	Total	927
Coal	1,950	Coal	1,000
Grand total	3,095	Grand total	1,927
First cost	$295,300.00	First cost	$246,200.00
Cost per I. H. P.	29.53	Cost per I. H. P.	24.62

	Steam power vessel.	Gas power vessel.
Interest, depreciation, and insurance	$27.620	$21,480
Coal, annually (150 days' steaming)	90,000	48,500
Service (engine and fire room crews)	30,000	12,000
Oils and stores	3,650	5,600
Repairs and sundries	15,000	12,000
	$166,270	$99,580
Annual saving	$66,690	
Added cargo capacity 1,150 tons.		
Value of added cargo carried	46,000	
Total saving	$112,690	

being about 10 per cent. on the whole cost of the vessel.

A great many gas engineers of prominence are to-day working on the gas turbine, and while it is yet too early to speak of this branch of the art, it seems, however, that this will be the ultimate solution of the propelling question for marine purposes for many years to come. The absence of reciprocating parts, the saving in weight and space, the absence of vibration, and no doubt considerable increase in economy, make it desirable that investigation should be furthered in this line. But, irrespective of this improvement, for economical reasons the steam engine must soon be supplanted by some other form of generating power. In this article an endeavor has been made to show what can be accomplished without any very radical departures in any instance from what is being done to-day, by simply taking advantage of the best practice on land and applying the same to marine purposes; a plant of very high economy, very low cost, light weight and small space has been designed and offered for the consideration of those interested.



BRITISH STEAMER INVERIC, AFTER COLLISION.
[Photograph by James Fisher, Hull, Eng.]

The Steamship Inveric in Collision.

The accompanying photograph is of the damaged bows of the steamship *Inveric*, after a collision off the coast of Spain on June 6, 1904, with the steamer *Kate B. Jones* of Cardiff. The latter steamer was very badly damaged, but the captain managed to run her aground, thus saving her from sinking in deep water. The *Inveric* was on a voyage from Calcutta to Hull, and the two ships collided in a dense fog. Immediately after the collision the captain of the *Kate B. Jones* put his wife, niece, and the ship's cook into a boat, but they were never seen again. The damaged bows of the *Inveric* were covered over with canvas and sails and she proceeded to Hull without assistance from any other vessel.

When the vessel was unloaded at Hull tenders were asked for the repairs, and she was sent to a firm at Newcastle-on-Tyne which completed all repairs in fifteen working days. The ship was built in 1901 by I. W. Hamilton & Company of Glasgow, and is owned by A. Weir & Company. The dimensions of the vessel are: 369 feet length between perpendiculars; 52 feet 1 inch molded beam, and 27 feet 2 inches molded depth.

NAVAL ARCHITECTURE.—III.

BY SIR WILLIAM H. WHITE, K.C.B., F.R.S.

During the last ten years no marked advance has been made in our knowledge of the scientific principles on which estimates for the structural strength of ships are based; but very much has been added to available data by the widened application of methods of calculation and comparison, for which we are largely indebted to the late Professor Rankine. In that admirable work, *Shipbuilding, Theoretical and Practical,* to which he made most valuable contributions, Rankine not merely indicated general procedure, but gave illustrative examples of methods of computing bending movements and sheering stresses, and regulating the longitudinal and transverse strength of ships. Mr. William Froude also dealt with this branch of naval architecture in a masterly and suggestive manner. Later investigators have advanced the investigation, particularly in connection with the transverse strength of ships, and the effects of rolling and pitching motion upon stresses borne by ships' structures. The Transactions of the Institution of Naval Architects contain the most valuable contributions to such knowledge. After making allowance for all that has been done in this direction, it still remains true—and, from the nature of the case, will probably always remain true—that the safest rule for naval architects is to base scantlings for new vessels upon comparisons with other vessels with which experience in actual work has been gained. Such comparisons must rest upon thorough analysis of all features in the problem which admit of exact treatment, and due allowance must be made for differences in forms, dimensions, and lading. Careful study of cases of partial failure, exceptional straining or other misfortunes to ships frequently furnish valuable information for guidance in future design, although, to individuals, they may be unpleasant and troublesome. Increase in the speeds and dimensions of ships have introduced many new conditions, and, in some instances, there have been indications of local or general weakness requiring modifications of structures; but, in proportion to the strides that have been made during recent years and the departures from precedent, cases of serious general structural weakness have been neither numerous nor costly. No doubt, we are still imperfectly informed as to the actual margin of strength existing in many structures, and it cannot be asserted that accepted systems of construction embody the best conceivable distribution of material for the association of lightness and strength. Brunel, in a famous passage of his notes on the *Great Eastern,* laid down the true principle of construction when he said that "no materials should be employed on any part except at the places, and in the direction, and in the proportion in which it is required, and can be usefully employed for the strength of the ship; and none merely for the purpose of facilitating the framing and first construction." This broad generalization is often overruled in practice by the desire to secure greater economy or rapidity in building, or by considerations of a practical nature involving accommodation, cargo-carrying power, or facilities for working cargo. In war ships, in particular, considerations of armament and protection often interfere radically with arrangements which, from the point of view of strength of structure, would be preferred. The installation of enormous engine power also introduces local conditions of an important character which cannot be disregarded. After making allowances for all these circumstances, the writer is disposed to believe that Brunel's principle could, with advantage, be more largely applied in ship construction than it has yet been; and the matter is one which must be dealt with courageously if full advantage is to be taken of the superior qualities and forms in which materials for ship building can now be obtained.

IMPROVEMENTS IN MARINE ENGINEERING.

Since 1894, there have been many improvements in the propelling apparatus of ships, tending to economies in weight and coal consumption. It would be out of place to enter into any detail of these, but they so greatly influence ship design that a brief reference must be made to the main lines of advance. From 1891 to 1901, it has been estimated by high authorities that for British mercantile steamers the average steam pressure rose from about 160 to 200 pounds per square inch; the average revolutions from about 64 to 87 per minute; the average piston speed from about 530 to 655 feet per minute; and the average coal consumption changed from 1.75 to 1.5 pounds per horse-power hour on prolonged sea voyages. With cylindrical boilers (tank type), which are universally used for merchant ships, 220 pounds per square inch is the maximum pressure adopted, and many engineers prefer to use a somewhat lower pressure. Steamers of high speed have higher rates of revolution, the piston speeds on service being 900 to 1,000 feet per minute. There is a consensus of opinion in favor of retaining long strokes in fast ocean steamers.

War ships are engined on a different system, largely because they ordinarily cruise at low speeds and rarely steam at maximum powers. Shorter strokes and higher rates of revolution are adopted, with greatly lessened weights, in proportion to maximum power and large economy of space. For battleships, 100 to 110 revolutions and piston speeds of about 900 feet per minute are used; for large cruisers, 120 to 140 revolutions and 1,000 feet piston speed; for small cruisers, 220 revolutions and 1,000 feet; for destroyers, 350 to 400 revolutions and 1,200 feet.

Water-tube boilers are now universally adopted for all classes of British war ships, with steam pressures of 250 to 300 pounds. The long-continued controversy on this subject has not ended; but enlarged experience has led to great improvements, and with recent types of boilers greater endurance and economy in coal consumption have been secured. The Belleville type has recently given better results, and there are many advocates of its extended use in British war ships. The advisory committee appointed by the admiralty do not favor this policy; and on their recommendation the three types used at present for large ships are the Yarrow (large tube), Babcock and Wilcox, and Niclausse. As a temporary expedient, and to secure economy of coal consumption at cruising speeds, the committee recommended the use in large ships of a small number of tank boilers in association with water-tube boilers. Personally, the writer never favored such a combination. It has been largely used in Germany. As was anticipated, it has been abandoned almost before the first examples were tried, the economy of coal consumption with recent water-tube boilers having proved greater than that of their predecessors.

With water-tube boilers in British war ships open stoke holds have been adopted, in association with powerful fans. In merchant ships some system of forced draft is largely used, that introduced by Mr. Howden finding most favor.

In the smaller classes of cruisers and vessels of the torpedo flotilla, water-tube boilers, with tubes of small diameter, and machinery of the "express" type, are necessarily adopted. The latest and largest application of this system is in the scouts now building. These vessels (360 to 370 feet long and about 2,900 tons displacement) are to have engines of 16,000 to 17,000 I. H. P., driving twin screws. The *Novik*, of the Russian navy, is very similar, but she has three screws. Great interest attaches to the trials of these vessels, particularly in regard to the utilization of their great power and the management and endurance of the engines. In such installations, closed stoke holds and high forced drafts are adopted. Recent trials have shown remarkable economy in coal consumption of destroyers, in association with moderate forced draft. Messrs. Yarrow have obtained, or exceeded, the full contract speed in some instances with less than 2 inches of water as the air pressure in stoke holds, and about 1.6 to 1.7 pounds of coal per horse power hour.

STEAM TURBO-MOTORS.

The practical application of steam turbines to ship propulsion, especially by Mr. Charles Parsons, has been delayed by various accidental circumstances, and partly by the necessity for solving many new problems. Encouragement was given by the admiralty to the new system, immediately after the *Turbinia* had been made successful, by ordering the destroyer *Viper*. This encouragement has been continued, not merely by ordering other destroyers similarly engined, but by extending the system to the *Amethyst*, a third-class cruiser, 360 feet in length, and 3,000 tons, with engines of about 10,000 I. H. P. This was the writer's last design of a small cruiser for the Royal navy, and he recommended the use of turbines. Her trials are now about to be undertaken, and will be of great interest. If they prove successful (of which there can be no doubt) it may be anticipated that the admiralty will apply turbines to much larger vessels.

Meanwhile the greatest experience has been gained with passenger steamers employed on cross-channel or coast service. Messrs. Denny showed the way with the *King Edward* for the Clyde, and the *Queen* for the Dover-Calais route. Now a large number of similar vessels are built, or building. Several yachts have been fitted with turbines. One of the latest of these was designed by the writer for Sir George Newnes, the turbines being specially arranged to give economy of steam at cruising speeds, which will be accompanied by the development of about 50 per cent. of the full power.

On the whole, experience with turbine machinery has been satisfactory, and its advantages in regard to freedom from vibration, reduced cost of working, maintenance and supervision, and diminished space and weight have been conclusively demonstrated. As to economy in the use of steam as compared with the best types of reciprocating engines, the most trustworthy information has been obtained in electric generating stations on land, where it has been proved that turbines are much superior at full power, about equal at 70 per cent. of the full power, and inferior to reciprocating engines for smaller percentages. Mr. Charles A. Merz, of Newcastle-on-Tyne, has probably made the most complete experiments on this matter, comparing reciprocating engines of high efficiency with turbines. As a result he has adopted turbines exclusively in his latest and largest generating station. Another fact, experimentally demonstrated, is that as the size of turbines increases so their relative economy is improved.

No doubt in destroyers and small vessels fitted with turbines it has been found that at low cruising speed and with small powers —not exceeding 10 per cent. of the maximum—the reciprocating engine has given much greater economy than the turbines actually fitted. This feature of turbine machinery is especially important for war ships, and is receiving close attention from Mr. Parsons and other engineers. Already modified arrangements of turbines and combinations of reciprocating engines and turbines are being tried. One of the most interesting experiments in this direction is that of Messrs. Yarrow, wherein a central reciprocating engine is associated with two turbines, each of the three developing about the same power at full speed, while at cruising speeds the central engine is used for propulsion. In the *Amethyst* this matter has been specially dealt with, and the comparative trials of that vessel alongside of sister cruisers with reciprocating engines will be of great interest and value.

Three or four shafts have been used in most of the turbine steamers, three, as a rule, being preferred. It is well known that, under the new conditions of extremely rapid rotation, the selection of the most suitable propellers has been a matter of great difficulty. In the *Turbinia* this was especially true, and Mr. Parsons showed the greatest courage and ability in the various modifications by which he achieved ultimate success. Very much remains to be done in this direction, and experiments alone can furnish the best solution. Reversing arrangements were not fitted in the *Turbinia*, but are essential to manœuvring power, and are now universally adopted. In some cases it appears that somewhat greater power in the reversing turbines would be advantageous. This is a detail easily dealt with when requirements are clearly stated. Of course such additional reversing power involves greater weight. In the *Turbinia* an extreme example was given of what the system could produce in regard to the proportion of weight to power. Subsequent experience has tended to lessened rates of revolution, increased reversing power, and other modifications tending to increase of weight. It is, however, undoubtedly true that turbines are relatively lighter than reciprocating engines. Messrs. Denny estimate that if the turbine steamer *King Edward* had reciprocating engines instead of turbines (the same boilers remaining), the speed would be reduced from 20.5 to 19.7 knots, corresponding to 20 per cent. difference in power.

In ocean-going passenger steamers built to work regularly at full power many of the difficulties above mentioned do not occur. The occasions are few, and not of long continuance, where the engines are worked at low power. Consequently the turbine system, for equal speed, should have a two-fold advantage, *viz.*, by reason of the less weight in proportion to power, and the more economic use of steam. On these points actual experience will soon be gained with the two turbine steamers now building for the Allan line. They are 520 feet long between perpendiculars and about 12,000 tons gross. The boilers are capable of supplying steam for 11,000 I. H. P. with reciprocating engines. There are three shafts, each driven by a turbine and carrying a propeller of small diameter. The average speed in moderate weather is to be 17 knots, but a higher speed should be readily obtained. An interesting comparison may be possible between the performances of these vessels and those of the *Moldavia* class of the P. and O line, which are very like in dimensions and power, but fitted with twin-screw reciprocating engines of the most modern type.

The decision to adopt the steam turbine system in the new Cunard steamships has aroused much interest, and surprise has been expressed in some quarters that an experiment of such magnitude should have been undertaken. It is, however, well known that before reaching the decision the chairman and directors appointed a strong and representative committee, who thoroughly investigated the matter experimentally and scientifically. The report of that committee has hitherto been treated as confidential by the Cunard Company, and any publication on the subject has been unauthorized and incomplete. As a member of the committee, and as consulting naval architect of the shipbuilding company, who are responsible for the design and construction of one of the vessels, the writer is fully informed, but not at liberty to enter into details. One point, however, may be dealt with as of general interest. Those who consider the course taken to be doubtful, naturally dwell upon the fact that, at one stride, an advance is to be made in the power of the turbines (as compared with the largest engines of that class yet fitted in any ship) fully as great as that which has been made, by successive steps, with reciprocating engines in the last forty-five years. It cannot be questioned that this great stride involves certain difficuties, particularly in the design of details and the conduct of manufacture. Nor is there any doubt but that experience—with its processes of trial and error, and its suggestions for successive improvements—is of immense value, when it is possible. This is the policy recommended by the writer for the Royal navy and adopted by the admiralty for turbine-propelled vessels. But the case of the Cunard steamships was altogether special. In order to obtain the desired speed an increase of at least 70 per cent. of engine power was required over that of the swiftest and most powerful existing Atlantic liner. As a consequence triple screws would have become necessary; and, even then, each engine would have largely exceeded in power any previous twin-screw engine, while there would have been little experience to go upon in designing efficient propellers, and these, with the reciprocating type of engine, would have been of great diameter. Moreover, the installation of three sets of machinery would have involved considerable difficulty, and one set would necessarily have been placed far aft, where the danger of serious vibration, even with the best balanced design possible, would have been great. Altogether it is certain that if reciprocating engines had been used in these vessels many experimental features would have been introduced, and some of these involved serious risks and drawbacks. These considerations are undoubtedly weighty, but they have been overlooked in some criticisms.

One incidental result of the use of quick-running steam turbines has been the extended use of triple and multiple screws, and the enlargement of experimental data in that direction. The writer's opinion in regard to triple screws as compared with twin screws, when reciprocating engines are used, is well known, and need not be restated. But with turbines the conditions are altogether different. Triple screws become a necessity in most cases, and in the Cunarders, quadruple screws were the best solution of the problem, having regard to engine design and propeller efficiency. The small diameters of screws possible with quick-moving turbines give great advantages, including deeper immersion, less probability of racing, and less augment of tow-rope resistance. Naturally experience alone can decide what is the best form and area of blades that can be adopted for each design; and it may well happen that in this particular the first trials may suggest the possibility of improvement in pitch ratio, or in blades. This is quite a common experience now, when unprecedented speeds are attempted, and all that can be done in either case is to take all possible advantage of previous experience in designing new propellers. It need hardly be added that this has not been overlooked in the Cunard designs.

THE OLD STEAMBOAT CONTINENTAL, NOW A COAL BARGE.

Steamboat Continental.

In the steamboat world, as well as elsewhere, the old must give way to the new, and every day sees the laying up and demolishing of old steamers which have been supplanted by vessels of modern construction. The accompanying photograph was taken of the former Long Island sound steamboat *Continental*, belonging to the New Haven line. She is now a coal barge.

PRACTICAL POINTS ABOUT THE SCREW PROPELLER.—I.

BY W. F. DURAND.

In this and following articles an effort will be made to treat the screw propeller in a simple and practical manner with reference to form and structure, delineation on the drawing board, design and adaptation to specific purposes, relation between conditions of operation and results obtained, and features relating to operation under special conditions. The purpose of these articles is to provide a simple answer, in so far as may be possible, to many of the practical questions which are continuously arising in connection with the design, construction, and operation of screw propellers for marine propulsion.

GEOMETRY OF THE SCREW PROPELLER.

We shall first consider the propeller as a geometrical body, and with reference to the varieties which may appear in geometrical form and proportion.

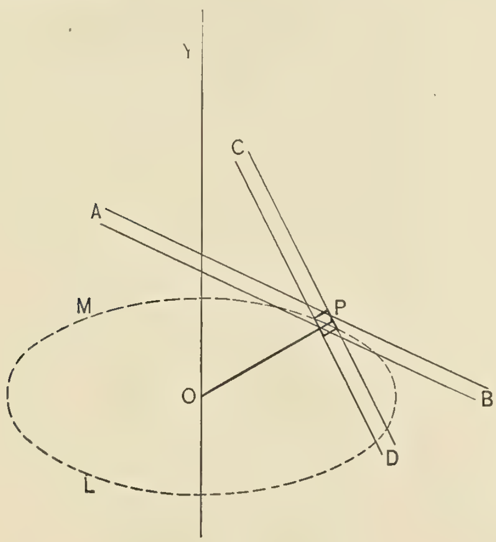


FIG. 1.

In Fig. 1 let OY be an upright shaft or axis, and OP a radius or line at right angles to OY. Suppose now that OP is turned about OY. The point P will trace the dotted circle seen in projection, and the line OP will trace the plane of this circle, PLM. Then let the rectangle about P represent a very small plane element carried on OP, and with its plane making an angle APC with that of the circle PLM. This may be more plainly seen by supposing the element at P to be a bit of thin metal with the rod OP soldered along one face, the rod being then turned until the piece of metal is tipped up as indicated in the figure. Such an element, if considered very small, would represent in the most general possible way the element of a screw propeller. Let us examine more carefully the relation of such an element to a screw propeller, and how a collection of them would form a propeller complete.

Suppose that while OP is revolved about OY as an axis it is also moved along OY in such way that the element P is always moving or sliding edgewise. Then the point P, say at the center of the element, will trace a path somewhat as seen in the curve PGC, shown in direct vertical projection in Fig. 2. If, again, we had such a curve to start with, it is clear that the element at P, Fig. 1, would exactly slide along such a curve, while the rod OP carrying it would turn, and at the same time move along the axis OY, with motion similar to that previously described.

Such a curve is known as a helix. Again, it is clear that each and every point of the radius OP, Fig. 1, will, when it is moved in this manner, trace a similar curve, and that the collection of such curves would constitute a surface. The same surface may also be considered as a collection of all the positions of the radius OP, Fig. 1, in moving as above specified. That is, if the axis OY were supposed to be drilled full of very small holes very near together, and in each one a rod were placed in such position as to just touch the curve PGC, then it is clear that the collection of such small rods or lines would form a surface somewhat as indicated in Fig. 2. It is also clear that such a surface may be considered as made up of a vast number of little elements similar to P, Fig. 1, but set at varying angles in accordance with the distance of the element from the axis, as will be seen more fully at a later point. A surface thus formed is known as a helicoid or helicoidal surface, and forms the face of the usual type of uniform pitch propeller with blades at right angles to the axis.

We must now turn back to the helix PGC, the path of the point P as it turns about OY as axis. It will be clear that, as defined, the point P, Fig. 1, and hence the curve PGC, Fig. 2, lie on the surface of a cylinder with OY as axis and OP as radius. Such a cylinder is represented in Fig. 2 by $CDFP$, with OY as the axis. Suppose now that we imagine the surface of such a cylinder formed by a sheet of paper and this sheet to be split down the element CP and then unwrapped. It will unroll or develop into a rectangular sheet shown by $PQRS$, Fig. 3, and the curve PGC, Fig. 2, will become a straight line, PR, Fig. 3. In Fig. 2 we have shown that part of the curve which would be traced by carrying the radius OP, Fig. 1, through one complete revolution about OY, or until in Fig. 2 the radius YC becomes parallel to the starting position at OP. Then, in Fig. 3, the developed curve will form a complete diagonal, PR of the rectangle $PQRS$.

The distance PC, or FD, or QR is called the pitch of the helix, or of the helicoidal surface. It represents, as may be seen, the distance which the helicoidal surface would progress forward were it to make one complete turn about its axis and at the same time slide along a smooth supporting surface of the same form. This is exactly realized by the movement of a bolt in a nut, and the ordinary screw thread of the bolt is a form of helicoidal surface similar to that under present consideration. In fact, for a square thread with the flanks at right angles to the surface, the flank of the thread is formed of a part of a helicoidal surface exactly such as that under present discussion.

This gives us the idea of pitch for the helicoidal surface as a whole. Suppose, then, that with such a surface as a support we

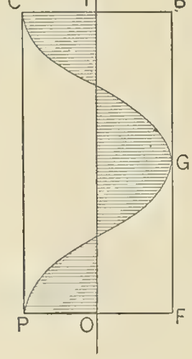


FIG. 2.

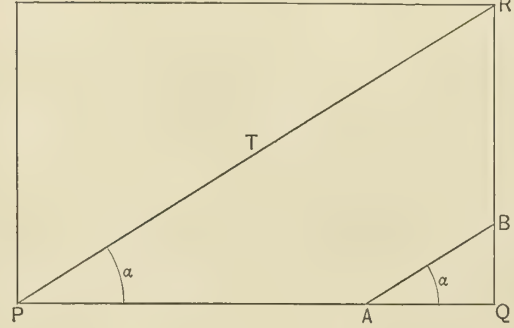


FIG. 3.

again take a single small element as in Fig. 1. Then if this element so moves as to slide along, always supported on the surface of the helicoid, it is clear that together with its radius, *OP*, it will, for one complete revolution, move axially this same distance, *PC* or *QR*, Fig. 2 or 3. This, again, is exactly similar to the movement of a small bit of the thread of a bolt sliding over the thread of a nut. It is important to see in this way that the idea of pitch belongs to the element *P* just as much as to the entire helicoidal surface in Fig. 2. It thus appears that the pitch of such an element as that in Fig. 1 is the distance which would be moved axially for a complete revolution of the radius *OP*, supposing the element to be supported on a corresponding smooth surface along which it can slide continuously, and without difference of direction between element and support at any point of contact between the two.

Let us then consider that we have thus developed a definition of pitch which relates to a small element such as that in Fig. 1. Pitch belongs then essentially to the element, and is determined in accordance with the definition above. This idea is of great importance and should be clearly grasped.

Now, it will be clear from these definitions, that at every point of a surface such as that in Fig. 2, the element has the same pitch, namely, the distance *PC* or *QR*, Fig. 3, and that a propeller made up of blades having a driving face formed of any part of this surface will also be of the same uniform pitch measured by *PC* or *QR*. To form the blade of an ordinary uniform pitch propeller we have only to select a part of such a helicoidal surface for the face, put on thickness so that it may be formed in actual materials, supply a hub, and the blade is ready for operation; and with two or three or four such blades, all similar and symmetrically distributed about the circumference, the propeller is complete.

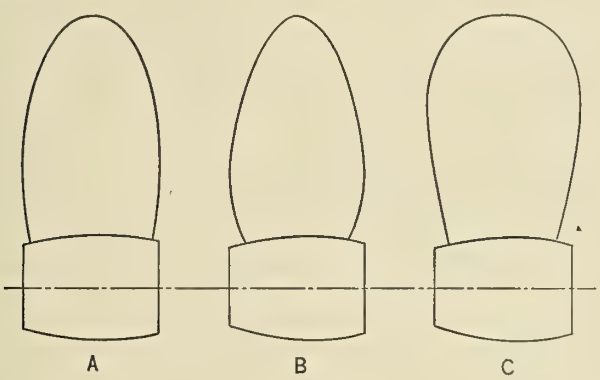


FIG. 4.

The contour of the blade is usually determined with reference to its so-called developed form. Strictly speaking, a surface such as that under consideration cannot be developed or rolled out flat without deforming or stretching it. The helicoid belongs to the same class of surfaces as the sphere in which the surface cannot be rolled out flat without deformation or stretching. In most propeller blades, however, the amount of such deformation would be very small, and we may in a general way safely assume that if a propeller is laid down on the drawing board as though the blade were flat, the actual blade when cast in the foundry will differ in area by no serious amount from that originally intended.

The actual developed shape of propeller blades in most modern cases is oval, or closely elliptical, as represented in Fig. 4A. In some cases the oval is somewhat pared off toward the outer end, as in Fig. 4B, massing the area relatively nearer to the hub; while in others the oval is broadened at the outer end in varying degrees, as indicated in Fig. 4C.

The propeller thus resulting, and as shown in Fig. 5, is of the common type with uniform pitch, and with blades at right angles to the axis. Let us now examine the more important variations from this common type.

Suppose, in Fig. 1, that *OP* instead of being set at right angles to the axis is tipped up or down at an angle as shown in Fig. 6. Then we may imagine *OP* revolved about *OY* with *P* guided on a helix exactly similar to *PGC*, Fig. 2. This movement of the radius *OP* will then generate a helicoidal surface somewhat simi-

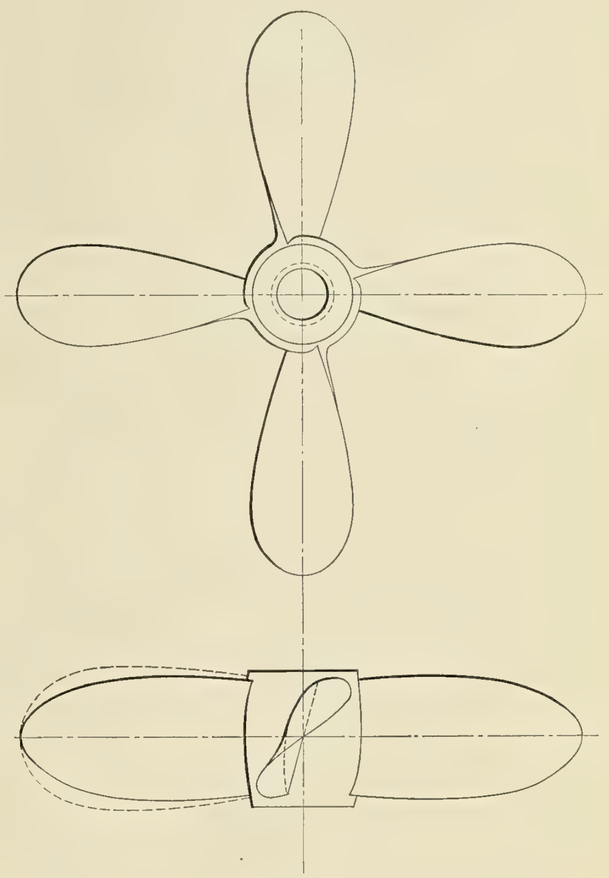


FIG. 5.

lar to that indicated in Fig. 2, but with the straight radial elements inclined at an angle instead of square with the axis. This surface is similar to that which would be formed in cutting a screw thread with a square-nosed tool if it were fed by a com-

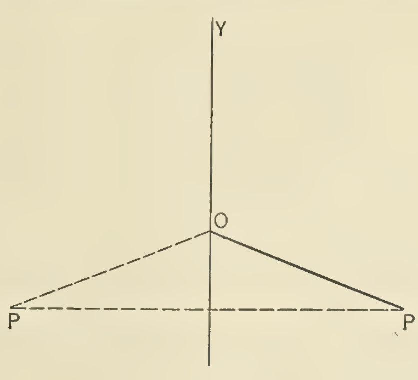


FIG. 6.

pound rest obliquely instead of square with the rod. It is, moreover, exactly the form of surface produced on the sides of a V-shaped thread as cut on an ordinary bolt. Now, the contour of a propeller blade may be laid off on such a surface as readily as on that in Fig. 2, and thus is formed a blade which stands tipped back from the plane of rotation, or with its radial elements oblique to the axis instead of square. As actually employed, the blades are tipped aft rather than forward, thus increasing clearance between propeller and stern post, or accommodating the location of the tips of the blades better with the arch of the propeller aperture. Such a propeller is shown in Fig. 7.

Again the shape of the blades is by no means symmetrical about a blade center line as indicated in Fig. 4. Quite commonly the leading or forward side is pared away and the after or following side is filled out somewhat as indicated in Fig. 8. Various modifications of this character may be made, and the area may be so distributed as to give to a propeller with elements at right angles with the axis the appearance of being bent or twisted in a variety of ways. As a rule, however, the modification thus made is of the nature shown in Fig. 8, AB denoting the after side of the blade.

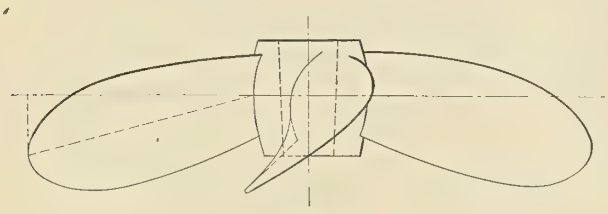


FIG. 7.

Turning again to Fig. 1, it is seen that the pitch of the propeller is determined by the angle between the element P and the plane of rotation, or APC. This is also equal to the angle QPR., Fig. 3, as may be readily seen. Now, the equality of pitch for the helix PGC, Fig. 2, at all points means simply that at all points on the curve the inclination is the same, and this is further shown by the development of the helix into a straight line, PR, which at all points is inclined at the same angle with PQ. Now, for Fig. 3, suppose we substitute Fig. 9. Let PUR be a curve, as shown,

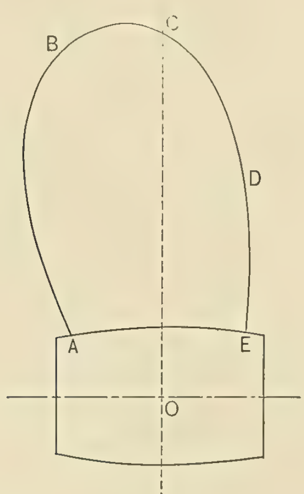


FIG. 8.

and suppose the rectangle wrapped up to form a cylinder. Then the curve PUR will form a helix, PGC, somewhat as shown. From P continuously to R the slope of the line PUR decreases, and, consequently, the pitch of an element of the helix will continuously decrease from P along PGC, Fig. 10.

We may obtain further light on this point by remembering that the pitch at any point as P, Fig. 9 will be the same as would be determined by the inclination of a line drawn tangent to the curve at this point. That is, it is the same as that of a uniform pitch helix having the same inclination as that at the given point. Such a tangent line is shown at PR_1, and the pitch is QR_1. In general, from the definition of pitch developed in connection with Figs. 2, 3, it will be seen that in any case the pitch of an ***element*** may be found by the following construction:

(1) Draw a base line such as PQ, Fig. 3, and equal in length to the circumference of the circle traced by the element.

(2) Draw at Q a line at right angles to PQ.

(3) At P lay off an angle QPT, equal to the pitch angle, and prolong the oblique line thus determined to meet the vertical at R. Then the distance QR will represent the pitch.

Applying this construction to the present case it is clear that we may find the pitch for any point S on the line PUR or its corresponding point on the helix PGC, by the following construction:

(1) Through the given point S draw a line tangent to the curve $PUSR$.

(2) Through P draw a line PR_2 parallel to this tangent.

Then the distance QR_2 will denote the pitch for this particular point in the helix or for any element of a propeller having the same radius and inclination. It thus appears that for such a helix as that in Fig. 10 the pitch will vary between limits as shown by QR_1 and QR_3, the latter being determined by a line PR_3 parallel to the tangent to the curve at R. Suppose now that as in Fig. 2 a radius revolves about OY, Fig. 10, and rests upon or is guided by PGC. Such radius may, moreover, be square with the axis, as

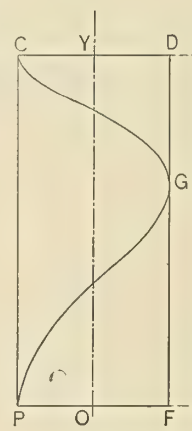


FIG. 10.

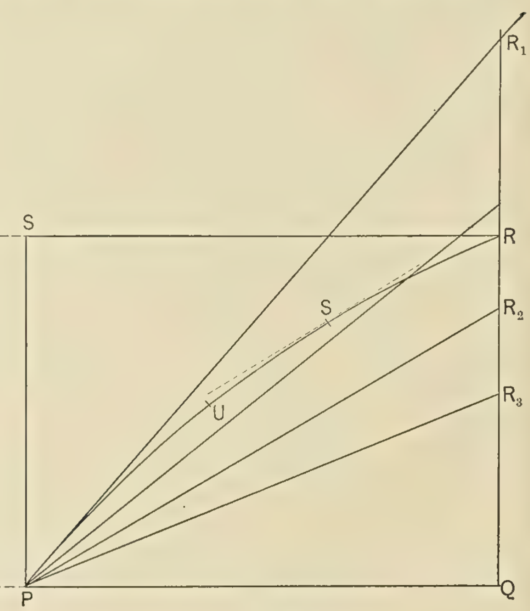


FIG. 9.

in Fig. 2, or inclined as in Fig. 6. A helicoidal surface will in either case be generated, based on the helix PGC as guide, and with the same variation of pitch as the helix, and as indicated in Fig. 9. Now, if a portion of such a helicoidal surface were taken for a propeller face, it is clear that the pitch would continuously increase across the face in the direction from R toward P, and decrease in the opposite direction. When the pitch varies across the face in this manner, it is made to increase from forward aft or from leading to following edge. In such case, therefore, if the part US should represent the portion of the curve actually embodied in the blade, the part toward S would give the leading edge and that toward U the following edge.

It will be clear from the foregoing that any variation of pitch across the face, no matter how complex, may be obtained by an appropriate developed form of helix. Thus, as in Fig. 11, we might have a straight line PU running into a reverse curve USR, and denoting from P to R first uniform pitch from P to U, then decreasing pitch to a minimum at about S and then increasing continuously to R. Such extreme variations have no especial value with reference to the screw propeller, but serve to show how easily the most complex kinds of pitch variation may be realized if desired.

We have thus far supposed the generating element of the helicoidal surface, as OP, Fig. 2, to be a straight line. This is by no means necessary, and it may be a line curved in various ways, either in the plane of rotation or in the plane of the axis. The former is indicated in plan view in Fig. 12, and the latter in Fig. 13. Such generating lines may be used with a guiding helix having any law of pitch, either uniform or variable, and the resulting propeller will have blades bent or twisted according to the generating line, and pitch according to the law of the guiding helix or that part of it actually used for the blade.

We must now note briefly another variety of pitch variation. It may be seen that if the construction in Fig. 3 for a uniform pitch propeller is repeated for a number of different diameters, a diagram like Fig. 14 will result, in which PQ_1, PQ_2, etc., represent

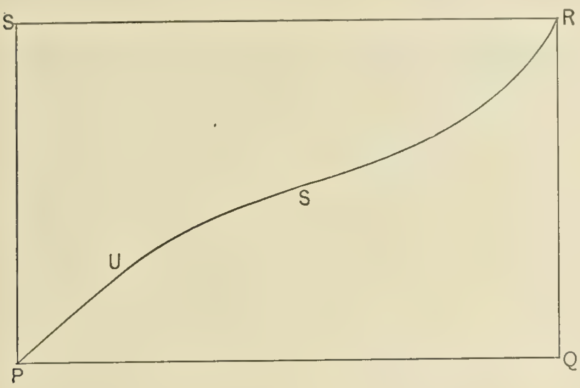


FIG. 11.

the various values of the circumference, and PS, Q_1R_1, etc., represent the constant value of the pitch. On the other hand, suppose that we start with a diagram, such as Fig. 14, taken as a collection of guide lines, and let each one be rolled up into a helix in the same manner as in Figs. 3 and 2. Such a collection of helical curves would then all fit the one helicoidal surface, and each would correspond to the fixed value of the pitch at its own radial distance from the axis. Suppose, however, that instead of PR_1, PR_2, and PR_3, we should take respectively PR^1_1, PR^1_2, and PR^1_5, each with its corresponding helix, for the guiding curve for the part of the surface at the corresponding radius. That is,

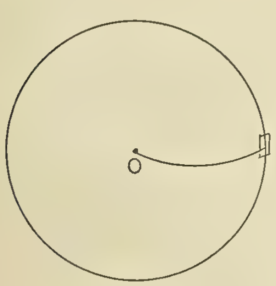


FIG. 12.

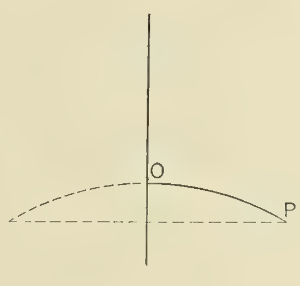


FIG. 13.

we may suppose that we have a surface, helicoidal in character, and yet so formed that the helix resulting from wrapping up $PVR^1_1Q_1$ will just fit it at the radius corresponding to circumference PQ_1, the helix resulting from $PTR^1_2Q_2$ at the radius corresponding to circumference PQ_2, and similarly for PR_3, PR_4, and PR^1_5. Then it will follow that at these distances from the axis the pitch will be represented by $Q_1R^1_1$, $Q_2R^1_2$, Q_3R_3, Q_4R_4, $Q_5R^1_5$, and will therefore vary from one location to the next from root of blade to tip.

In a more general way we may represent such a change of pitch by the diagram of Fig. 15. Let PQ_1 represent the circumference at the hub and PQ_5 that at the tip. Then let $R_1R_2R_3R_4R_5$ be a curve giving proportionately the change of pitch from root of blade to tip. Then any line such as Q_2R_2 will give the pitch at the radius corresponding to the circumference measured by PQ_2, the angle R_2PQ_2 will give the inclination of the element, and if the rectangle PQ_2R_2S be wrapped up to form a cylinder, the diagonal PR_2 will form the helix which would exactly fit such a helicoidal surface at this radius. It must be noted that such a surface cannot be generated by sweeping up a single radius in the manner suggested in Fig. 2. In a surface swept as in Fig. 2 the pitch at all points on the radius for any one position is the same while in the surface under present discussion the pitch along any line drawn from hub to tip will vary continuously according to the

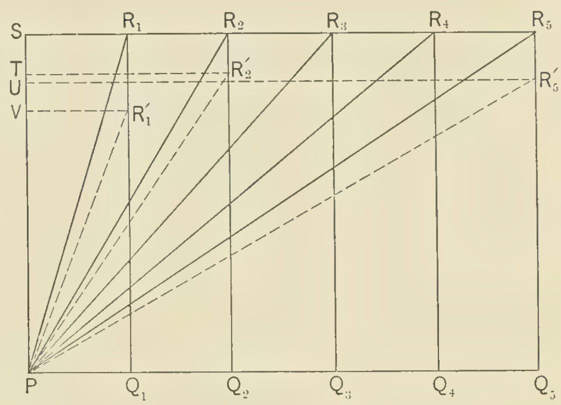


FIG. 14.

law indicated in Fig. 15. Instead, therefore, of trying to consider such a surface as formed of a series of radial elements, as in

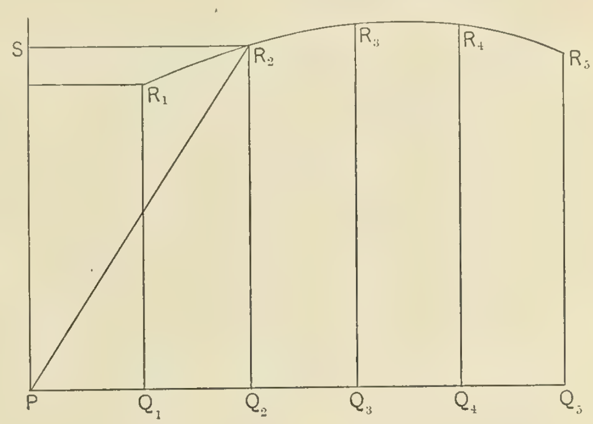


FIG. 15.

Fig. 2, we may consider it as built up of an indefinitely great number of helical curves placed one outside the other, and each with pitch as indicated by the diagram in Fig. 15. In such a propeller, therefore, the pitch would increase from a value Q_1R_1 at the hub to a maximum Q_3R_3 about two-thirds the way toward the tip, and would then decrease to a value Q_5R_5 at the tip.

Variation of the pitch in this manner may also be combined with variation from leading to following edge, as shown in Fig. 9, and in this way the most complex variations in pitch may be produced. The principles involved in the determination or delineation of propellers of any variation of pitch are, however, all contained in the preceding paragraphs, and their application with illustration of further points, will be found in the following chapter on the drawing-board delineation of propellers, both of the standard type with uniform pitch, or with such variations in its distribution over the face as may be desired.

(To be continued.)

ELECTRIC STEERING CONTROL OF SHIPS.

One of the most interesting applications of electricity on shipboard is certainly to be found in electric steering control, permitting the pilot to transmit instantly and in an absolutely sure and certain manner the most definite orders to the steersman, and to receive in return a definite and permanent indication of the position of the helm.

The Allegemeine Electricitäts Actien Gesellschaft, of Berlin, was one of the first companies to elaborate a general design for electric steering control, and the German government shortly after authorized a trial of the same on the naval ship *Baden*. The results having been definite and satisfactory, several armored ships

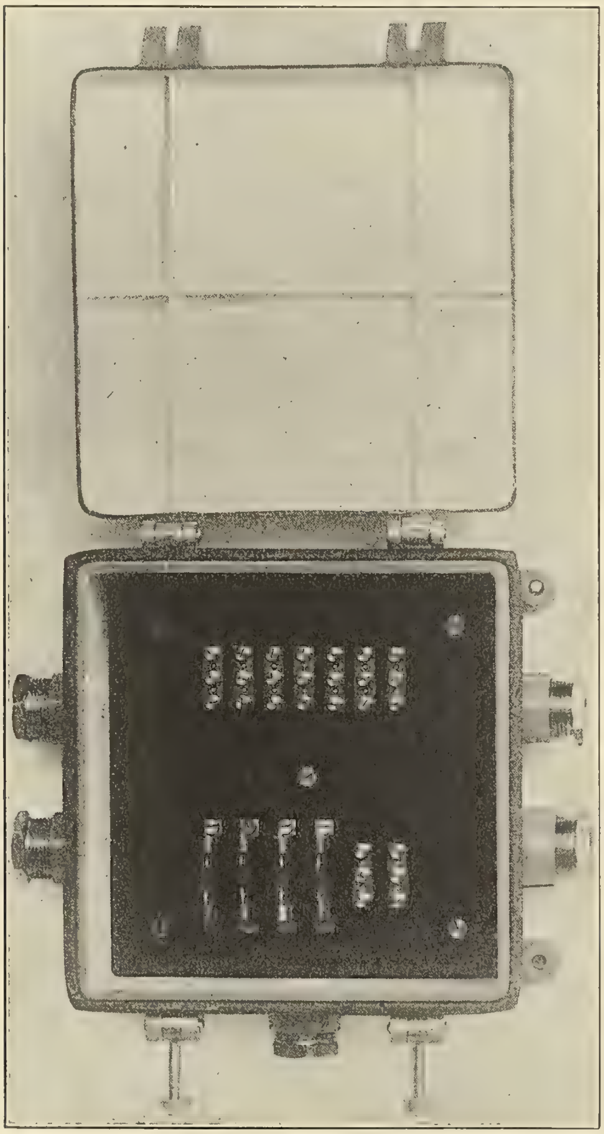


FIG. 1.—BOX I.

were later provided with a similar system, and from indications but a short time will elapse before all the principal units of the German navy are provided with this mode of electric steering control.

The installation on the *Baden* divides itself in reality into two distinct parts, one for the transmission of orders from different command points to the steersman at the wheel, the other for the constant, automatic indication at several points simultaneously, of the position of the helm. These installations comprise the following elements:

1. For the transmission of orders:
   - (*a*) A transmitter placed in the forward conning tower or on the forward bridge.
   - (*b*) A similar apparatus at the central command point.
   - (*c*) A receiver provided with a call bell, and located at the wheel.
2. For indicating the position of the helm:
   - (*a*) A transmitter contact indicator operated by the rudder head.
   - (*b*) An indicator placed in the steering room, in each engine room, on the forward bridge and at the central command point where this apparatus is joined to the two transmitters.

The apparatus is installed in three boxes made carefully watertight; see Figs. 1 and 2, with arrangement plan, Fig. 3. The wiring is installed throughout of marine cable in armored conduit. The current of about 8 amperes for the entire installation is taken

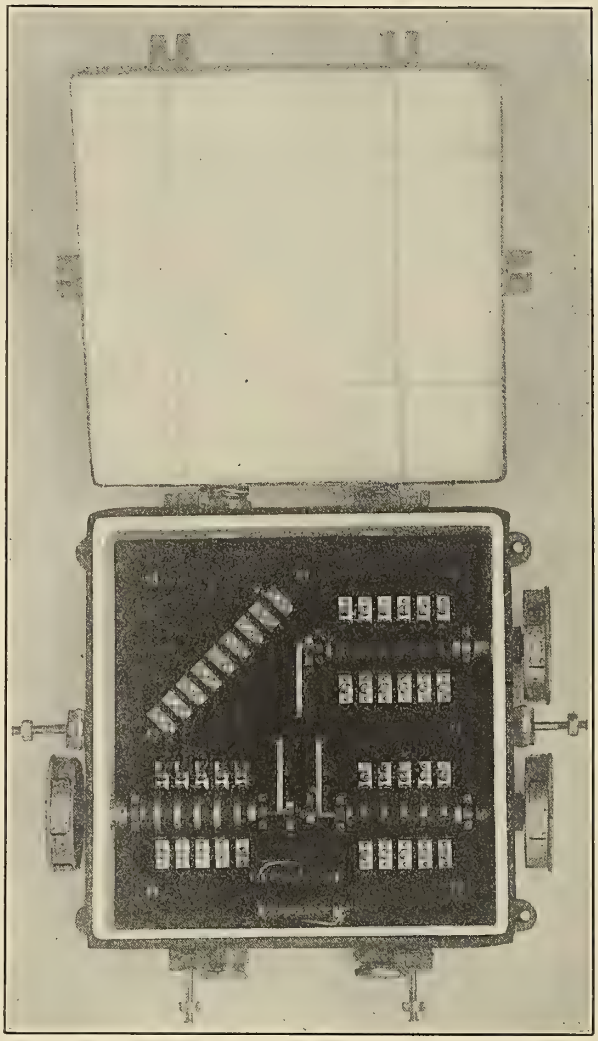


FIG. 2.—BOX III.

from the main lighting circuits by means of a bi-polar commutator with conductors of ample section and leading to a resistance, where the pressure of 67 volts is reduced to 28, the pressure adopted for the apparatus. From this point the current is brought by a cable of five conductors to the distribution boxes. In Box 1, Fig. 1, are gathered the cables of the receiver for the helm telegraph, for the transmitter position indicator of the latter, and for a further indicator. In box 2 are joined the cables for the two indicators in the engine rooms. Box 3, Fig. 2, located at the central point of command, constitutes the point whence are led the cables for the two helm telegraphs, and for the position indicator on the forward bridge. Box 3 is provided with means for cutting out, in case of battle, the double connection from command points, in order to avoid the danger of transmission from different points of orders at the same time.

The cover of this box, Fig. 3, is furnished with reference points, and there are hand wheels with similar marks, thus providing for a ready indication of the connections which may exist at any given moment. The wheel *b* serves to put in circuit the helm position indicator in the armored conning tower, and the wheel *c* that located on the forward bridge. Fig. 3 gives the arrangement plan of the system as well as the interior operation of the apparatus. In order to facilitate the assemblage of the apparatus the cables and connections are marked with reference numbers, as per plan.

Before giving further description of the apparatus employed, brief reference should be made to the principle of the rotating field employed in the position indicators. This system involves the distribution on three conductors of a continuous current by means of a distributor in such a manner that in the receiver, which comprises a tri-polar magnetic system, a magnetic field is constantly developed, electrically dependent on the distributor, with which it rotates constantly in step.

In further description, the term "transmitter" will refer to that part of the apparatus in which the subdivision of the current is effected; the term "distributor" to the rotating part of the transmitter and the term "receiver" to the part containing the resultant magnetic field and rotating magnet.

The transmitter is usually constructed of two different types, for a large or a small number of orders. The transmitter for a large number of orders, Figs. 4 and 5, comprise a certain number of metal blocks and plugs for closing circuit, between which are connected resistance coils, unequal and graduated according to a certain law. This circle of resistances, closed by itself, receives at two fixed points, *a* and *b*, directly opposite each other, the current from the supply point as noted above, while three rotating contact bars, *c*, *d*, *e*, at angles of 120 degrees and insulated from each other, take each a part of the current and send it by corresponding conductors to the receiver.

The transmitter for a small number of orders, Fig. 6, consists essentially of three principal contact points with three transmission wires, and a certain number of auxiliary contacts, *b* and *c*, arranged in a circle and connected by resistances I, II, III, with their principal contact point. The current is led to the transmitter by means of two brushes at opposite ends of a diameter and connected with the source of current. The angle of the principal contacts is 60 degrees, and that of the secondary depends on the number of orders for which provision is to be made. A transmitter for 48 orders, for example, requires only 21 contacts. The current is distributed to the connecting ring by two double brushes *d*, during the rotation of which the three wires, G_1, G_2, G_3, joined to the three principal contacts, are connected with varying resistance, the conductors themselves being in multiple, in series or singly, in manner to produce in the magnetic system of the receiver a magnetic field rotating with the distributor, as already explained in connection with the other type of transmitter.

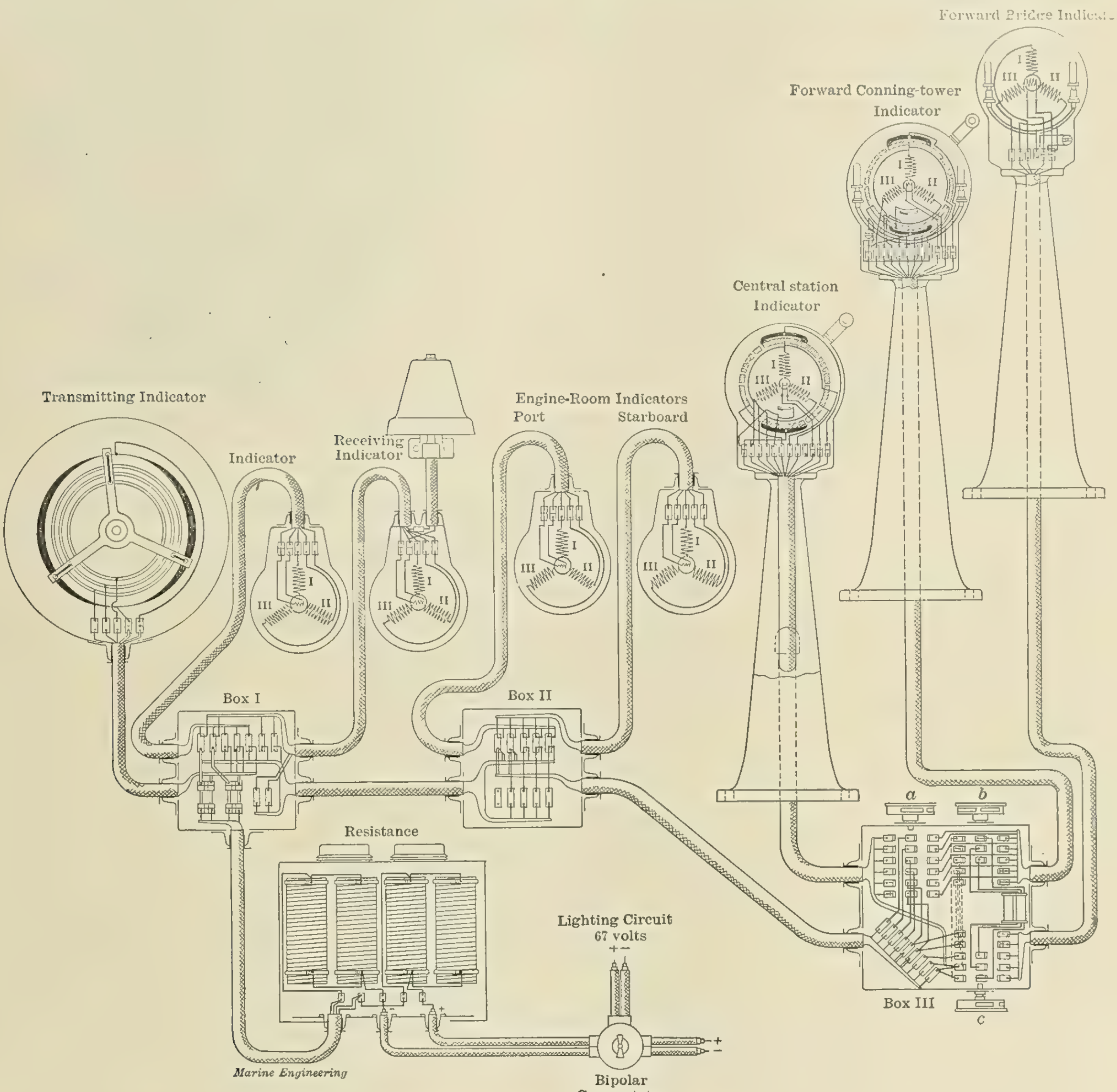


FIG. 3.—HELM INDICATOR WIRING PLAN.

The receiver, see Fig. 7, is composed of three pairs of coils, *r*, disposed radially about a copper cylinder *k*. These coils are in all cases placed in circuit two and two, and connected with one of the transmission lines coming from the transmitter. The ends of the wires from these three pairs of coils are joined to a single terminal where they have their neutral point. At the center of these radiating coils is placed the inductor element, to which is directly attached the indicating needle. The inductor element is formed of two pieces of soft iron, *g*, in the form of a Z, and connected to each other by a piece of insulating material, *h*. The energization of the rotating points, *g*, is effected by means of two coils, *i*, connected up in such manner that there is formed in each Z-shaped core a pronounced north and south pole. The copper cylinder, *k*, surrounding these Z-formed pieces serves effectually to dampen the indicating system.

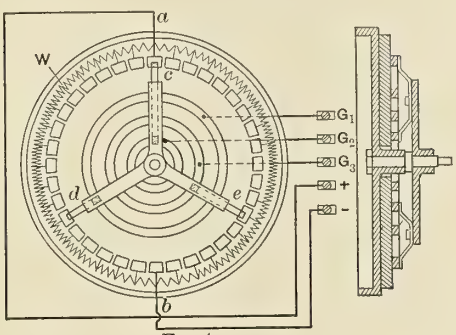


Fig. 4

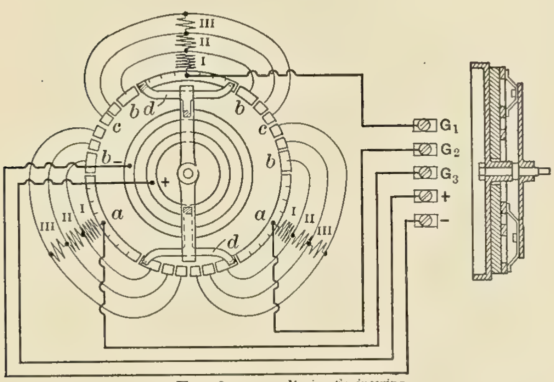


Fig. 6 *Marine Engineering*

FIGS. 4 AND 6.

The operation of this type of indicator is as follows: If, for example, the three-armed distributor of the transmitter *I* is moved over the surface of the resistance circle the proportions of the current in three conducting lines are modified according to the resistances inserted; and in consequence of the mutual relations of the three conductors and the resistances involved, the resulting current is sinusoidal in form. As the trace of the current shows, the maxima of current intensity in the three conductors are distributed at relative phases of 120 degrees. These three conductors leading to the three pairs of coils in the receiver, there is produced at this point, and according to the intensity of the indivdual currents, individual magnetic fields which unite in a resultant field, of which the direction always coincides with that of the distributor. This field traverses the central space of the receiver system and forces the rotating inductor element to follow its rotation.

Due to the fact that with this system of transmission one can obtain an unlimited number of positions, it is unnecessary to introduce any gearing connection between the inductor element and the needle moving on the face of the indicator. From these various dispositions it results as follows:

(1) To each position of the lever of the transmitter there can correspond but one position of the needle of the indicator.

(2) The inductor system of the receiver is not reversible, and in consequence any departure of the indicator from synchronism is rendered impossible.

(3) Variations of potential are without effect on the position of the indicator.

As we have already noted, this form of shunt transmitter is

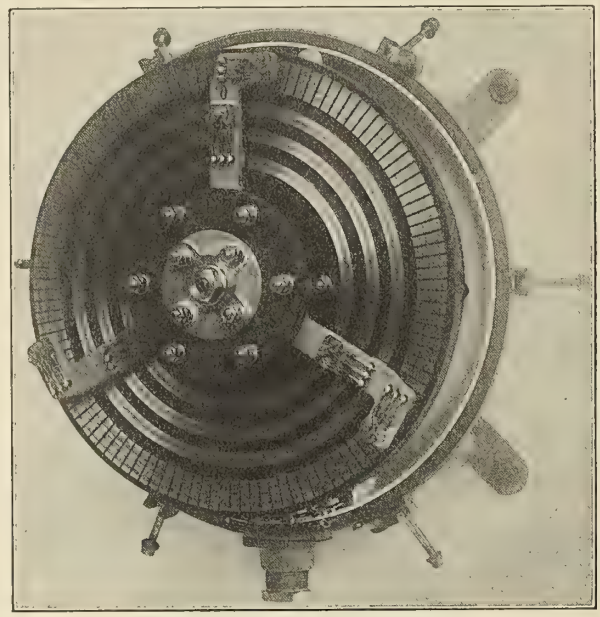


FIG. 5.—TRANSMISSION INDICATOR.

adapted to the transmission of a large number of orders, and is therefore used for the automatic helm position indicator. For the transmission of orders to the helmsman, a much smaller number of indications is required, and the other system is employed.

We shall now refer briefly to the chief constructive details of these two forms of apparatus. For the helm position indicator the general arrangement is shown in Fig. 4. On the anterior face of a disk contact points to the number of 120 are arranged in a circle, together with three collecting rings, while the resistance coils are placed at the back. The three-arm contact system is also mounted on an insulated disk carried on a movable axis. This axis carries

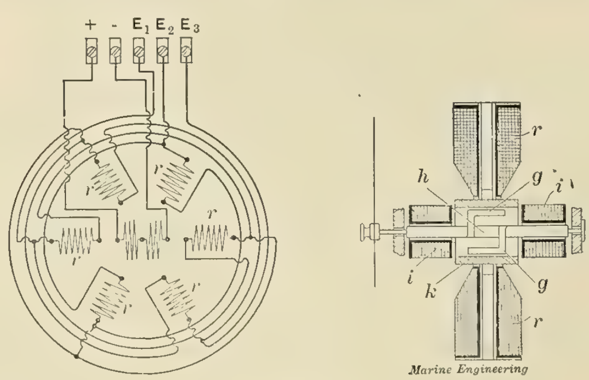


FIG. 7.

on its anterior part a little boss with two grooves, while a similar boss is fixed on the rudder head, see Fig. 8, and thus transmits by means of a steel wire the movements of the rudder head to the transmission system in the direct ratio of 1 to 3. The second groove of the small boss receives the wire of the return mechanism, consisting of a counterweight and tension key.

As indicated by the diagram, the counterweight acts in a direction opposite to that of the movement of the rudder, so that the transmitter is put into operation in one case directly by the pull of the wire from the rudder head segment and in the other by that of the counterweight. The key serves to adjust the tension as may be desired.

For the transmission of orders to the helmsman the general arrangement is shown in Fig. 6, comprising a transmitter for a moderate number of orders, and a receiver. Both transmitter and receiver are mounted in water-tight boxes, from which, however, they may be readily withdrawn without breaking the electric connections. Orders may be transmitted for every five degrees, and for each new order a warning bell signal is sounded automatically at the steering station.

The principles governing the operation of this system of transmission and indication had been known and employed to some extent before its perfection and wider development were undertaken

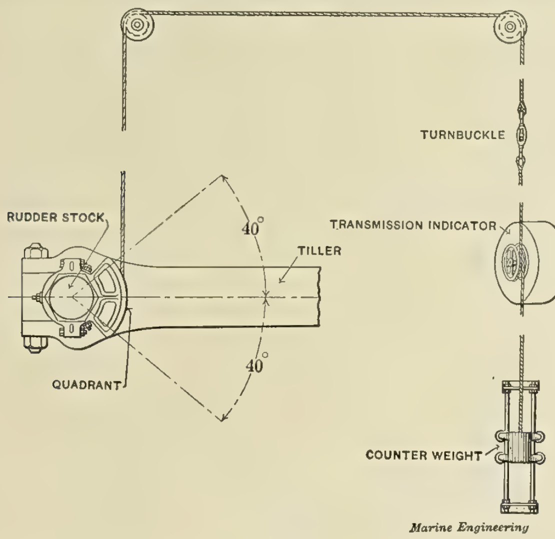


FIG. 8.

by the company referred to above. The chief difficulties have arisen in connection with the protection of the apparatus from the effects of exposure to salt humidity. Oxidation naturally results and the consequences are either the refusal to work or faulty indications. The company whose apparatus is herein described has given special attention to these matters, and by means of stuffing boxes and other points of special construction has developed the structural details in such manner as to insure immunity from disturbances of this character.

Low Bids for War Ships.—Unprecedentedly low bids were offered December 15, for the construction of the battleship *New Hampshire* and the armored cruisers *Montana* and *North Carolina,* proposals for which were opened at the Navy Department at noon in the presence of representatives of shipbuilding companies from the Pacific and Atlantic coasts. The lowest bids offered were for the cruisers, $3,575,000 each by the Newport News Shipbuilding Company, and for the battleship $3,748,000, by the New York Shipbuilding Company. Not more than two ships can be awarded to one company. The lowest aggregated bids for these three ships was exactly $1,377,000 less than the aggregate lowest bids for three sister ships a little over a year ago, a reduction of 11 per cent. in price.

Twenty-Thousand-Ton Battleships.—A 20,000-ton battleship is proposed by some of the government navy experts, as it is claimed it would possess very great offensive and defensive powers. It is proposed to make the main battery uniform and to consist of ten 12-inch guns placed in turret and broadside, while the secondary battery is to be made up entirely of about twenty 3-inch guns. The armor of this type would be but little heavier than that of the *Connecticut* class. The advocates of this radical change point to naval engagements of the Russian-Japanese war to show that the 6-inch gun, which is very largely used on the American battleships, is practically useless against armored vessels at long range, and that the success of the Japanese resulted from the preponderance of heavy guns on their ships. It is also claimed that to resist torpedo attack the new 3-inch gun is as effective as any other.

POWERING SHIPS.—I.

BY EDWIN CERIO, NAVAL ARCHITECT.

I.

One of the principal factors involved in the design of a ship is the indicated horse power necessary to drive her at a given speed. Too much accuracy can scarcely be obtained on this side of the complicated problem, as the elements upon which the solution depends are of such a nature that they cannot, strictly speaking, undergo mathematical investigation. What is aimed at is the best obtainable approximation, and only very accurate and patient work will secure this.

The practice of some designers has often been that of overpowering ships, and thus, by making a sure error in the right direction avoiding a probable error in the wrong direction. But if the simple fact that an error, either way, is always an error, is not enough to convince such designers that their practice is not to be recommended, they must be convinced of this if they look at the economical side of the question, especially in these days of industrial war in which many a battle is fought on horse powers, as the builder who will drive a ship at a given speed with the right amount of power, is sure to offer a cheaper tender than the one who makes the error in the right direction. Of course, the problem of powering a ship is but the determination of the ship's resistance. Resistance of floating vessels has been the object of investigation for many centuries, and to determine it, formulæ of every description have been given, some based on purely analytical speculation, others on experiments, and most of them starting from a completely false conception of the phenomena with which they deal.

It was really only in 1870 that a new era began for such studies, and the problem treated with mathematical and experimental investigation, both very happily combined. The traditional fundamental ideas have been replaced by modern views; an important factor, skin-resistance, has been thoroughly studied and the dynamical law of similitude applied to the theory of ships, so that the problem of resistance of vessels now assumes altogether a new aspect. This is due principally to the classical experiments of Froude, and after him to such men as have helped to popularize his theory—R. E. Froude, Reed, Denny, Risbec, Rota, Durand, Mittendorf, Rauchfuss, Gareis—only to mention a few, and whose works may very profitably be consulted.

The determination of the resistance of ships is done to-day by means of model experiments, using directly for this purpose experimental tanks, or the results gathered by such researches. The first tank was built by W. Froude at Chelston Cross. Froude's example was soon followed in Italy and in France, where Risbec carried out a series of very important investigations at Brest. In Germany, notwithstanding the very little sympathy model experiments enjoy, a tank was built by the North German Lloyd, and another one has just been completed at Charlottenburg, near Berlin. Since the year 1887, in which the tank in Spezia, Italy, was completed, the results of experiments carried out by Rota have added most precious material to the theory of resistance. The United States seem to have realized how such investigations are indispensable, and must be done at home by a nation whose navy has developed so rapidly and successfully. Experimental tanks are also in Russia, and it may be said in all countries in which naval problems are studied and solved. The purpose of these tanks is not only, as is thought by many, to determine for a given ship the power which will drive her at a desired speed, but to gather rationally all the results obtained and to investigate all the questions that arise on propulsion, stability of ships, etc., and it is clear that when these experimental methods become more popular they will furnish naval architects more reliable data than the empirical formulæ which have led, in many cases, to unpleasant experiences.

II. INDICATED HORSE POWER AND EFFECTIVE HORSE POWER.

If V be the speed of the ship in knots, v be the speed of the ship in feet per second, W the resistance in pounds, the effective horse power necessary to drive the ship at the speed V will be:

$$EHP = \frac{W \times v}{540}$$

The indicated horse power is equal to the effective horse power divided by a coefficient of efficiency:

$$E = \frac{EHP}{IHP}$$

This coefficient E depends upon the efficiency of engines and propeller and from many elements which cannot be considered for every single case; therefore, no fixed rule can be given for selecting a value of E suitable to any particular ship. The designer must be guided in this choice by experience and his own judgment; the values given in the following tables will, in all ordinary cases, lead to sufficiently accurate results. Where extreme exactness is not required, for example, when making estimates, the EHP may always be assumed to be the half of the IHP, and therefore $E = 0.50$.

In Table I. values of E are given for different types of ships.

TABLE I.

	Values of E.
Single-screw merchant ships, full forms, coefficient of fineness between 0.8 and 0.7	0.40
Single-screw merchant ships, coefficient of fineness about 0.6	0.50
Double-screw ships, vertical engines	0.50-0.60
" " " horizontal engines	0.40-0.45
Vessels of very fine forms, great speed, vertical engines	0.55-0.65

The elements upon which E depends are of too complicated a nature to allow any law being given to determine in every special case appropriate values, and the best way to proceed is to get reliable data of ships similar to the projected ship. A few examples may show how the values of E vary, sometimes governed by no progressive law, and sometimes in a certain relation with the speed. The following are the results of trials of:

A TUG BOAT.

Speed in knots	7	8	9	10	11
Values in E	0.51	0.54	0.533	0.535	0.46

A TORPEDO-BOAT DESTROYER.

Speed in knots	12	14	16	18	20	22	24	26	28
Values of E	0.457	0.507	0.533	0.574	0.606	0.618	0.628	0.644	0.666

SOME ITALIAN CRUISERS.

Pellicano.

Speed in knots	13.13	15.80	17.72	20.34	23.05
Values of E	0.444	0.526	0.478	0.482	0.495

Calabria.

Speed in knots	12	16.4	14.5
Values of E	0.4	0.41	0.42

Dogali.

Speed in knots	15.5	18.5
Values of E	0.39	0.45

Lombardia.

Speed in knots	10	18
Values of E	0.48	0.42

Piemonte.

Speed in knots	20.17	20.3	22.4
Values of E	0.41	0.41	0.59

Agordat.

Speed in knots	18.78	22.7
Values of E	0.33	0.417

When it is necessary to obtain accurate results, it will be well to analyze separately the various causes which influence the coefficient E. All agree in the definition of indicated horse power, which is the mechanical work developed by steam in the cylinders of an engine, taking the horse power as unit; but some confusion still exists in the definition of effective horse power; if the IHP is the power required to give the total thrust, the EHP is that part of it which is opposed to the net resistance of the ship. Thus defined, as it usually is, the EHP appears only as an abstract conception; the relation between EHP and IHP is of a complicated nature and not easy to be determined. To start from a simple case, we can consider a ship which is being towed; the amount of mechanical work in every unit of time is here equal to the EHP. But when propulsion is obtained by other means than towing, the resistance of the propellers, which are attached to the hull, must also be considered, and instead of an amount EHP of power, a certain amount $(1 + K)$ EHP will be required to obtain the propulsion at the same speed. This amount of power is not all furnished by the propeller, because the vessel is surrounded by a mass of liquid in motion, which may, so to speak, help the propulsion if the stream lines move in the direction the vessel moves in, and therefore the propellers shall furnish an amount of power which may be expressed by:

$$P_3 = (1 - h)\ (1 + K)\ EHP \text{ or } P_3 = \frac{1}{E_3} EHP.$$

The coefficient E_3 depends upon the so-called *ship-performance,* but it must be remembered that it is dependent upon two distinct factors, one $(1 + K)$ which considers the additional resistance of propellers, and the other $(1 - h)$ which depends upon the stream lines and consequently upon the ship's form.

The next co-efficient to be considered is that which takes into account the mechanical performance of propellers, and this is:

$$E_2 = \frac{P_3}{EHP}.$$

If P_2 is the amount of power which is to be furnished to the propeller, that is, the power measured on the propeller shaft, it is necessary that the motive fluid, steam in steam engines, should develop an amount of power, IHP, equivalent to the work of the total thrust, or, in other words, equal to P_2 augmented of the mechanical work of all the internal resistances of the engines; the coefficient

$$E_1 = \frac{P_2}{IHP}$$

gives the performance of the engines. The product, $E_1\, E_2\, E_3 = E$, is the coefficient of total performance; as the product $E_1\ E_2$ is independent of the performance of engines, and may be called the net coefficient of performance. The propeller coefficient E_2 has a mean value of 0.65 when the propeller is designed to work in the most favorable conditions of performance; the extreme limits of E_2 are 0.6 and 0.7.

Investigations on the values of E_3 are scarce, but those carried out by means of model experiments seem to prove that in the greatest number of cases, for vessels of ordinary forms, $E_3 = 1$.

In practice it is advisable in considering E_1 and E_2 to refer to their product, $E_1\ E_2$, to which we shall refer, from hence, as E_I; the coefficient of performance of the engines we shall call E_{II}. As said above, some confusion exists in the meaning of EHP, and especially of that part which depends upon E^I; it is measured sometimes abaft, sometimes forward of the thrust block, sometimes at the stern post. To avoid this confusion it would be wise to adopt Herr Föttinger's suggestion* and measure the engine's effective horse power always at the stern tube.

Whenever model experiments for the designed ship may be carried out, and values of E_{II} determined for the propeller and ship, it will be always better to separate E_I and E_{II}, because reliable values of E_I are always obtainable and may be assumed with sufficient exactness.

According to Riehn:

For big engines	$E_1 = 0.80$ to 0.90
small "	$E_1 = 0.75$
big ships	$E_2 = 0.75$
small "	$E_2 = 0.55$.

For most cases the following table may furnish good values of E_I

*Fottinger.—Effektive Maschinenleistung und effektives Drehmoment. Yahrbuch der Schiffbau technischen Gesellschaft, 1903.

TABLE II.

E.H.P.	E_I	E.H.P.	E_I	E.H.P.	E_I	E.H.P.	E_I
10	0.575	500	0.68	1,000	0.747	3,000	0.87
100	0.61	600	0.695	1,300	0.775	4,000	0.895
200	0.63	700	0.71	1,600	0.80	5,000	0.90
300	0.65	800	0.72	1,900	0.825	6 000	0.91
400	0.67	900	0.735	2,200	0.84	7,000	0.915

Föttinger investigates separately the different losses of power from the cylinders to the propeller, and mentions the loss due to vibrations, which is usually not taken into consideration.

The following are average values of these losses in percentage of the total horse power developed in the cylinders:

	Per cent.
Loss due to the friction of pistons	0.5
" " " " " " stuffing boxes	0.5
" " " " " " guide blocks	4.0
" " " " " " connecting rod gudgeons	1.5
" " " " " " crank shafts	2.0
" " " " " " bearings	2.0
" " " " " " valve gear	5.0
" " " " vibrations caused by the engines	4.0
" " " " friction of thrust block	2.0
" " " " first shaft bearing	0.4
" " " " second "	0.4
" " " " third "	0.4
" " " lignum-vitæ bearings	2.5
" " " stern tube stuffing box	0.8
" " " the vibrations of propeller	4.0
	30.0

Therefore, of the original *IHP* only 70 per cent. arrives at the propeller, thus giving a coefficient $E_I = 0.70$.

This is a good average value, and as a mean value of E_{II} may be assumed equal to 0.65; when estimating the *IHP* it will always be safe to assume:

$$E = E_I \, E_{II} = E_1 \, E_2 \, E_3 = 0.45.$$

It is scarcely necessary to call attention to the fact that the *IHP* as considered up to this point is only what is strictly indispensable for the propulsion of the ship; a good practice is that of adding to this part of the *IHP* that which is absorbed by auxiliary machinery driven by the main engines. In vessels of modern construction it may be assumed that:

	IHP
Air pumps absorb	0.001-0.002
Circulating pumps absorb	0.002-0.005
Feed " "	0.005-0.006
Bilge " "	0.001

When fans for the combustion are also driven by the main engines they absorb about 0.005 to 0.015 of the *IHP* estimated for the propulsion.

III. HORSE POWER ESTIMATED BY MEANS OF COEFFICIENTS OF PROPULSION.

Much of the practical value of experimental investigation is sometimes lost owing to the difficulty of assuming a correct value of the ratio $\frac{EHP}{IHP}$. This, no doubt, partly accounts for the favor the so-called *IHP* constants enjoy with most designers, especially with those more conservative in their practice, but it is not a sufficient reason to advocate the purely empirical methods of calculation of the *vieille école*. The use of constants, in experienced hands, may be of great help to designers, provided they possess much data upon which they can rely, because it is nothing but the comparison of a projected ship to others which have been constructed, and whose trial results are at hand.

The use of *IHP* implies the direct comparison of power instead of resistance, that is, of mechanical work instead of forces, based on the law of similitude, and the conditions under which this comparison is possible should not be lost sight of: geometrical similitude of forms, corresponding speeds of ships and propellers, and, as far as possible, engines of the same type.

What speaks in favor of these empirical methods is the fact that they are founded on a rational basis, and that, when comparing ships, it is not necessary to subdivide the total resistance into its elements.

Owing to the fact that all power curves present the characteristics of parabolas, and to the traditional assumption that the resistance of vessels varies with the second power of the speed, passing from the notion of resistance (force) to that of power (mechanical work), all formulæ giving the power necessary to propel a ship at a desired speed may be put under the general form:

$$IHP = K \, D \, V^3.$$

Constants deriving from this or any similar expression may have a practical value only when it is distinctly understood that such expressions apply only to speeds comprised in a very limited field. Instead of the displacement *D* alone, other geometrical elements of the vessel may be considered at the same time. The constants

$$G_1 = \frac{AV^3}{IHP}, \; G = \frac{D^{\frac{2}{3}} V^3}{IHP}, \; G_2 = \frac{SV^3}{IHP}$$

where *A* is the area of the midship section in square feet, *S* the wetted surface in square feet, *D* the displacement in tons, and *V* the speeds in knots, have been calculated for different ships of the Italian navy* and given in Table III. The table gives comparative values of these constants for a number of vessels of every description, more values of the well-known admiralty constant *G* being given for a greater number of ships in Tables IV*a* and IV*b*.

TABLE III.

RELATION BETWEEN POWER AND SPEED. RESULT OF TRIAL TRIPS OF SOME ITALIAN SHIPS.

Name and Description of Vessel.	Displacement tons	Speed knots	I H P's Constants		
			$G_1 = \frac{A. \, V^3}{I H P}$	$G = \frac{D^{\frac{2}{3}} \, V^3}{IHP}$	$G_2 = \frac{S. \, V^3}{IHP}$
Battleship *Re Umberto*	13,500	19	764	230	14,000
"	13,500	15	839	250	15,500
"	13,500	10	732	220	13,700
Battleship *Morosini*	11,000	16	775	235	14,100
"	11,000	12	689	215	12,400
"	11,000	10	635	195	11,300
Battleship *Garibaldi*	7,400	19.5	646	205	14,600
Cruiser *Marco Polo*	5,000	15	623	260	17,600
"	5.000	12	818	295	20,000
"	5,000	9	993	325	22,000
Cruiser *Fieramosca*	4,000	13	603	210	14,000
Cruiser *Etruria*	2,500	19	495	170	11,500
"	2,500	17	603	200	14.200
"	2,500	10	807	270	18,300
Cruiser *Minerva*	850	19	431	170	14,500
"	850	15	538	215	18,300
"	850	10	570	230	20,000
Destroyer	250	30	419	206	18 000
"	250	25	377	180	15,800
Torpedo-boat	150	26	371	190	16,150
"	75	20	248	125	10,400
"	75	16	312	160	13,450
Transport *Trinacria*	8,500	16	656	248	17,450
Training ship *Vespucci*	2,700	13	678	205	21,300
Transport *Europa*	1,500	8	560	200	......
Tug-boat *Atlante*	800	13	323	100	7,650
Tug-boats	120	9	290	85	4,950
	30	9	...	80	......
Steam Launches	5	7.5	...	65	......

Next in importance to the admiralty formula is the so-called French formula giving the constant $m = \sqrt[3]{\frac{A}{IHP}} \times V$.

It may be worth while mentioning a formula worked out by Mr. O. Richter, which, combining the advantages of the English admiralty formula and of the French, may be of aid in all those cases where speedy calculations are of more use than great

*The data are taken from Scribanti's *Lezioni di Teoria della Nave, II.*

accuracy. Mr. Richter considers a prismatic body in which the length, depth, and displacement remaining constant, the midship section varies: he finds that the resistance becomes a *minimum* when

$$A = \frac{Displacement}{0.6\ L}.$$

This he calls the most favorable midship section; variations of 10 per cent. of this section only produce variations of 1 per cent. in the resistance of the prismatic vessel. He therefore suggests introducing this value in the French formula, which may be therefore written:

TABLE IV*a*.—RELATION BETWEEN POWER AND SPEED. TRIAL RESULTS OF MERCHANT SHIPS.

Description of Vessel.		Geometry of Vessel. Displacement. Tons.	Length at the W. L. Feet	Area of Mid-sect. Square Feet.	Coefficients of Fineness δ	φ	β	α	I. H. P.	Speed. Knots.	Third Power of Speed.	Approximate Values of: G.	m.	K.
1		2	3	4	5	6	7	8	9	10	11	12	12	13
Ocean liners.	I.	22,600	663	1,792	0 631	0.665	0.949	0.749	37,800	23.52	13,011	274	8.51	10.8
	II.	21,050	625	1,600	0.627	0.675	0.928	0 739	28,000	22.00	10,648	289	8.48	12.8
	III.	17.300	523	1,493	0.746	0.650	0.958	0 859	7,200	15.00	3,375	314	8.90	15.5
	IV.	11.350	502	1,232	0.579	0.641	0.902	0.732	16,100	19.80	7,762	244	8.42	11.0
	V.	8,960	436	1,092	0.598	0.650	0.920	0.769	8,800	17.70	5,545	272	8.80	13.0
Cargo and passenger steamers.	* I.	24,200	561	1,894	0.773	0.806	0.960	0.869	5,400	13.50	2,460	377	9.48	19.6
	II.	19.400	561	1,505	0.761	0.815	0 933	0.870	5,500	13.0	2,167	285	8.41	13.6
	III.	17.200	522	1,493	0.741	0.772	0.961	0.834	9,000	16.5	4,492	332	9.07	16.6
	IV.	20 800	500	1,752	0.782	0.829	0 943	0.876	4,000	12.0	1,728	327	9.14	17.8
	* V.	18,750	500	1,670	0.757	0.786	0 963	0.858	3,600	12.6	2,000	392	9.76	20.9
	VI.	17,900	500	1,543	0.776	0.803	0 958	0.860	5,000	13.0	2,197	300	8.77	15.7
	VII.	11 350	453	1,150	0.679	0 721	0.941	0.798	5,000	13.9	2,685	272	8.54	13.5
	VIII.	9 660	429	1,010	0.710	0.764	0 929	0.871	3,600	13.9	2,685	338	9.22	16.8
	IX.	12,190	429	1,241	0.767	0.800	0.958	0.855	2,500	11	1,331	281	8.74	15.1
	X.	11 910	420	1,220	0.780	0 822	0.949	0.843	2,700	11	1,331	257	8.45	14.0
	XI.	9.900	406	1,110	0.697	0.723	0.963	0.820	3,200	13	2,197	316	9.15	16.7
	XII.	9,170	381	1,048	0.754	0.795	0.948	0 857	2,800	12	1,728	270	8.65	14.8
	XIII.	7,760	344	966	0.798	0.8.6	0.966	0.887	1,700	11	1,331	307	9.10	18.2
	XIV.	3 345	262	645	0.655	0.699	0.937	0.817	700	9	729	232	8.75	13.3
	XV.	2,320	251	413	0.735	0.786	0.936	0-861	930	10	1,000	189	7.63	9.9
	XVI.	1,730	207	402	0.698	0 744	0.940	0.850	440	9	729	239	8.74	13.8
	XVII.	864	174	262	0.618	0.689	0.927	0 804	401	9.265	795	179	8.05	9.8
	XVIII.	926	151	316	0.720	0.730	0.980	0.858	350	8	512	139	7.76	9.0
Passsengers' excursion steamers.	I.	5.620	400	686	0.634	0.717	0.844	0.790	3,700	15	3,375	288	8.56	12.8
	II.	667	172	226	0.533	0.605	0.882	0.761	1,018	13	2,197	104	7.90	8.3
	III.	150	98	96	0.380	0.533	0.712	0.682	300	11.23	1,416	133	7.67	7.2
	IV.	129	106	74	0.578	0.593	0.975	0 717	225	12	1,728	195	8.30	9.3
	V.	65	85	44	0.447	0.607	0.738	0.687	250	12	1,728	111	6.73	5.3
Pilot boat.	I.	360	115	170	0.485	0 657	0.740	0.770	300	9.1	753.6	127	7.54	7.9
Tugs.	I.	334	110	....	.....	.....	.....	.....	649.6	12.39	1,902	140	....	8.9
	II.	334	116	173	0.465	0.581	0.800	0 717	517	12.1	1,771	164	8.42	9.9
	* III.	46.8	49.2	56	0.485	0.606	0.800	0.760	150	9.1	753.6	65	6.55	4.8
	IV.	41 7	50.5	46.4	0.401	0.545	0.735	0.714	95	9	729	92	7.46	6.3
Steam launches.	I.	24.2	49.2	26.9	0.492	0.656	0.750	0.725	58	8	512	71	6.21	4.3
	II.	23.1	49.2	27.6	0.484	0 620	0.770	0.660	63	8.5	614	76	6.46	4.6
	III.	22.7	41.0	32.8	0.475	0.624	0.761	0.770	50	8	522	80	6.97	5.7
	IV.	19 75	45.3	25.4	0.403	0.615	0.664	0.742	53	8.2	551	73	6.42	4.3
	V.	12.32	38.4	19.4	0.42	0.584	0.720	0 703	94	9.2	778.7	41	5.44	2.7
									13.3	7	343	134	7.15	7.1
									15.9	7.5	422	138	7.20	7.3
									20.7	8	512	129	7.04	6.9
	VI.	11.80	42.6	15.9	0.429	0 605	0.708		29.2	8.5	614	109	6.66	5.8
									41.9	9	729	90	6.26	4.8
									59.4	9.5	857	75	5.86	4.0
									80	10	1,000	65	5.60	3.5
Paddle steamers.	I.	248	177	69.5	0.702	0.714	0.985	0 781	540	13.5	2.460	180	6.82	6.4
	II.	97 5	133	34.4	0.764	0.774	0.989	0.784	250	11.1	1.368	115	5.72	4.0

*It has not been possible to ascertain if the trial results of the ships marked * are quite reliable.

$$IHP = \frac{V^3}{m^3} \times \frac{D}{0.6L},$$

or

$$IHP = \frac{V^3}{K} \times \frac{D}{L}.$$

Adopting this formula, where

IHP is the indicated horse power,

V the speed in knots,

D the displacement in tons,

L the length of the ship in feet,

K a constant,

it may be found very useful for rapid calculation, as the constant *K* is easily obtainable from ships similar to those projected.

The last three mentioned formulæ may, if used by experienced designers, furnish with some approximation good results, and may serve, when making estimates, to compare a projected ship to one of which reliable speed and power data are obtainable.

The following tables, IV*a* and IV*b*, contain the values of the constants *G*, *m* and *K*, calculated for a great number of vessels of every description, each represented in the tables by a Roman figure, and of which the actual speed trials have been considered. Most of the vessels chosen are of the latest design, and every care has been taken to get the most reliable information obtainable. For some ships it has been found interesting to give the results of progressive trials, in order to show how the constants vary for small variations of speed and power. Almost every class of vessel, naval and mercantile, is represented in these tables, and together with the relation between power and speed, the principal geometrical features of the ships are given as follows:

Displacement in tons.

Length at the water line in feet.

Area of midship section *A* in square feet.

And the coefficients of fineness:

$$\text{Block coefficient } \delta = \frac{\text{displacement volume}}{\text{length} \times \text{breadth} \times \text{draft}},$$

$$\text{Prismatic coefficient } \varphi = \frac{\text{displacement volume}}{A \times \text{length}},$$

$$\text{Midship section coefficient } \beta = \frac{A}{\text{breadth} \times \text{draft}},$$

$$\text{Water-line coefficient } \alpha = \frac{\text{w. l. area}}{\text{length} \times \text{breadth}}.$$

The *IHP* constants, contained in Tables IV*a* and IV*b* are:

$$G = \frac{D^{\frac{2}{3}} \times V^3}{IHP};\ m = V \times \sqrt[3]{\frac{A}{IHP}};\ K = \frac{D}{L}\,\frac{V^3}{IHP}.$$

Formulæ are given to determine at once the horse power without having to find first the ship's resistance; the following, cited by Johow, is by Thornycroft.*

TABLE IV*b*. RELATION BETWEEN POWER AND SPEED. TRIAL RESULTS OF WAR SHIPS.

Displacement of Vessel.		Geometry of Vessel. Displacement. Tons.	Length at the W. L. Feet.	Area of Mid-sect. Square Feet.	Coefficients of Fineness. δ	φ	β	α	I. H. P.	Speed. Knots.	Third Power of Speed.	Approximate Values of: G.	m.	K.
1		2	3	4	5	6	7	8	9	10	11	12	13	14
Battleships.	I.	14,800	400	....	.....	.....	.....	.....	3,058	11.6	1,561	308	....	18.9
									11,670	16.97	4,887	253	....	15.5
									15.556	18.04	5,871	228	....	13.9
	II.	12,600	413	1,661	0.600	0.675	0.913	0.755	16.000	18	5,832	197	8.47	11.1
	III.	11,500	411	1,481	0.577	0.664	0.869	0.768	15.000	19	6,859	232	8.83	12.8
	IV.	11,000	396	1,483	0.570	0.657	0.865	0.704	14,000	18	5,832	203	8.54	11.6
First-class cruisers.	I.	11,800	440	....	... .	.....	.....	.....	4.780	14.457	3,020	327	....	17.0
									16.510	20.45	8,242	258	....	13.4
									21,302	21.365	10,142	246	....	12.7
	II.	9,650	440	....	.....	.....	.....	.....	4 711	15.676	3,850	370	....	17.9
									11.326	20.49	8,603	238	....	11.7
									22,189	22.38	11,209	229	....	11.1
	III.	6,658	429	906.8	0.485	0.590	0.822	0.728	1,150	10	1,000	308	9.25	13.5
		6,652		905.7					1,475	11	1.331	319	9.35	14.0
		6,645		905.1					1,920	12	1 728	318	9.34	13.9
		6,638		904.2					2,480	13	2,197	312	9.30	13.7
		6,631		903.4					3.190	14	2,744	303	9.20	13.3
		6,624		902.5					4,080	15	3,375	292	9.12	12.7
		6,617		901.4					5,160	16	4,096	279	8.96	12 2
		6,610		901.4					6,520	17	4.913	265	8.81	11.6
		6,603		899.3					8.200	18	5.832	248	8.60	10.7
		6,596		899.2					10 580	19	6,859	228	8.36	10.1
		6,589		898.2					13,820	20	8,000	203	8.06	8 9
	IV.	5,635	401	901.4	0.437	0.550	0.854		13,030	21.59	10,063	232	8.75	10.2
		5,904		937.5	0.477	0.554	0.860		14,100	21.51	9,952	230	8.74	10.3
		6 217		980.6	0 483	0.558	0.866		12,700	21.02	9,287	246	8.96	11.3
		6,223		981.1	0.483	0.558	0.866		11,400	20.48	8,589	254	9.05	11.7
		6.135		969.3	0-482	0.557	0.864		7,150	17.75	5.592	261	9.11	11.9
		5,904		947.2	0.477	0.554	0.860		6,970	17.67	5,517	259	9.06	11.7
		6.173		974.1	0,482	0.558	0.865		7 720	17.59	5.442	237	9.05	10.8
		5,904		937.5	0.477	0.554	0.870		6,950	17.54	5,396	253	8.98	11.4
		6,173		974.1	0 482	0.558	0.865		4.500	15.2°	3,512	262	9.13	11.9
		5,904		937.5	0.477	0.554	0.860		4,230	15.17	3,491	270	9.12	12.1
		5,173		974.1	0 482	0.558	0.865		2,618	12.79	2,092	268	9.20	12.3
		5,904		937.5	0.477	0.554	0.860		2,368	12.51	1,958	269	9.20	12.1
		6,167		973.1	0.482	0.558	0.865		2,370	11.09	1,599	226	8.70	10.3
		5,904		937.5	0.477	0.554	0.860		2,338	11.66	1,585	221	8.61	10.0
		6,173		974.1	0.482	0.558	0.865		8,900	18.67	6,508	246	8.95	11.2
		6,095		963.4	0.481	0.557	0.863		8,950	19.32	7,211	269	9.21	12.2
		6,132		969.0	0.482	0.557	0.864		3,940	14.13	2,821	240	8.86	10 9
		6.132		969.0	0.482	0.557	0.864		4,000	15.25	3,546	298	8.91	13.5
Second-class cruisers.	I.	5,791	354	... ...	.....	.....	.....	.....	2,636	13.5	2,460	300	....	15.3
									8,972	19.24	7,122	256	....	13.0
									12,781	21.09	9.380	236	....	12.0
	II.	4,261	325	752.3	0.094	0.610	0.810	0.706	8 000	18	5,832	191	8.21	9.6
	III.	3,915	361	651.6	0.478	0.586	0.814		9.850	20.53	8,653	218	8 32	9.5
	IV.	2,602	342	452.9	0.452	0.577	0.783	0.671	6,000	10	6,859	216	8.30	8.7
Coast defence ships.	I.	3,440	247	759.2	0.563	0.638	0.877		4,750	14.73	3.196	154	8.04	9.1
	II.	3.425	247	756.0	0.566	0.638	0.888		4,500	14.85	3,274	165	8.20	10.1
Scouts.	I.	2,019	325	351.1	0.516	0.618	0.835	0.629	5,400	19	6,859	202	7.66	7.9
	II.	1,344	246	317.7	0.455	0.636	0.715	0.667	2,808	17	4,913	212	8.24	9.6
	III.	1,054	185	....					1,435	13.33	2,368	170		9.4
Torpedo boats and torpedo boat destroyers.	I.	64.8	115	33.1	0.472	0.595	0.793	0.676	800	18.5	6 332	127	6.30	4.5
	II.	81	118	42.4	0.460	0.566	0.813	0.525	1,206	20.7	8,870	137	6.79	5.0
	III.	88.4	124	44.9	0.471	0.554	0.851	0.625	1,350	21.5	9,938	143	6.93	5.2
	IV.	157.1	151	65.3	0.447	0.555	0.806	0.613	2,400	33.0	12 167	147	6.94	5.3
	V.	262	179	92.2	0.460	0.567	0.811	0.613	2,200	22.0	10,648	197	7.66	7.1
	VI.	358.5	214	96.1	0.465	0.610	0.762	0.713	5 000	26.0	17,576	175	6.89	5.9
	VII.	532	225	....	.....	.....	.....	.....	6,957	25.6	16,777	157	....	5.7
	VIII.	542	225	....	.....	.....	.....	.....	7,633	25.87	17,314	151	....	5.5
	IX.	541	220	....	.....	.....	... .	.....	6,967	25.64	16,856	161	....	5 9
	X.	532	225	....	.....	.....	.....	.....	7,119	25.57	16,718	154	....	5.6
	XI.	541	220	... ...	.....	... .	.....	.....	7,028	25.72	17,014	161	....	6.0
	XII.	197	165	....	.....	.....	. ...	.....	2,871	25.296	16,188	191	....	6.7
	XIII.	197	165	....	.....	.....	.....	.....	3,030	25.33	16,252	180	....	6 4
	XIV.	197	165	....	.....	.....	.....	.....	2,926	25.44	16,465	188	....	6.7

$$IHP = KV\left\{ \int \Omega \frac{3n}{2n + L} V^{1.7} + G \frac{n^{\frac{1}{3}} + 3}{L^{\frac{1}{3}} + 3} V^{3.7} \alpha\Omega \right\}.$$

In this formula:

V is the speed in knots,

$$\alpha\,\Omega \int = \sin^{2.5} ds.$$

where α is the angle which the superficial element ds makes with the direction of the ship's motion, and the coefficients k, f, n, and G are to be determined as follows:

Log k = 3.65450 .... k = 4513.0
Log f = 2.10170 .... f = 126.4
Log n = 2.57978 .... n = 380.0
Log G = 2.20041 .... G = 158.6

The formula is supposed to give very good results, but it is rather too complicated for rapid calculation; the expression

$$\int \sin^{2.5} \alpha\, ds$$

may be easily determined;** the length, L, is given in feet. In the Russian and French practice Afonassief's formulæ are often used, and in most cases these lead to very accurate results. These formulæ*** are:

*See also Transactions of the Institute of Naval Architects, vol. x.

**A similar expression is to be found in Rauchfuss' formula, and a method for calculating it is given by Johow.

***Congres d' Architecte et de Constructeurs Navies, 1900. M. Afonassief: Formules Pratiques pour le Mouvement du Navire.

$$IHP = 1{,}000\left(\frac{BD^2}{L^2}\right)^{\frac{1}{3}}\left(\frac{V_0}{A_0}\right)^{\frac{10}{3}},$$

and

$$IHP = \frac{1{,}000}{1 - \varphi_0}\left(\frac{BD^2}{L^2}\right)^{\frac{1}{3}}\left(\frac{V_0}{A_0}\right)^{\frac{10}{3}},$$

the first to be employed when the propellers have no slip, the second in propellers with a slip.

In these formulæ:

D is the displacement in tons,

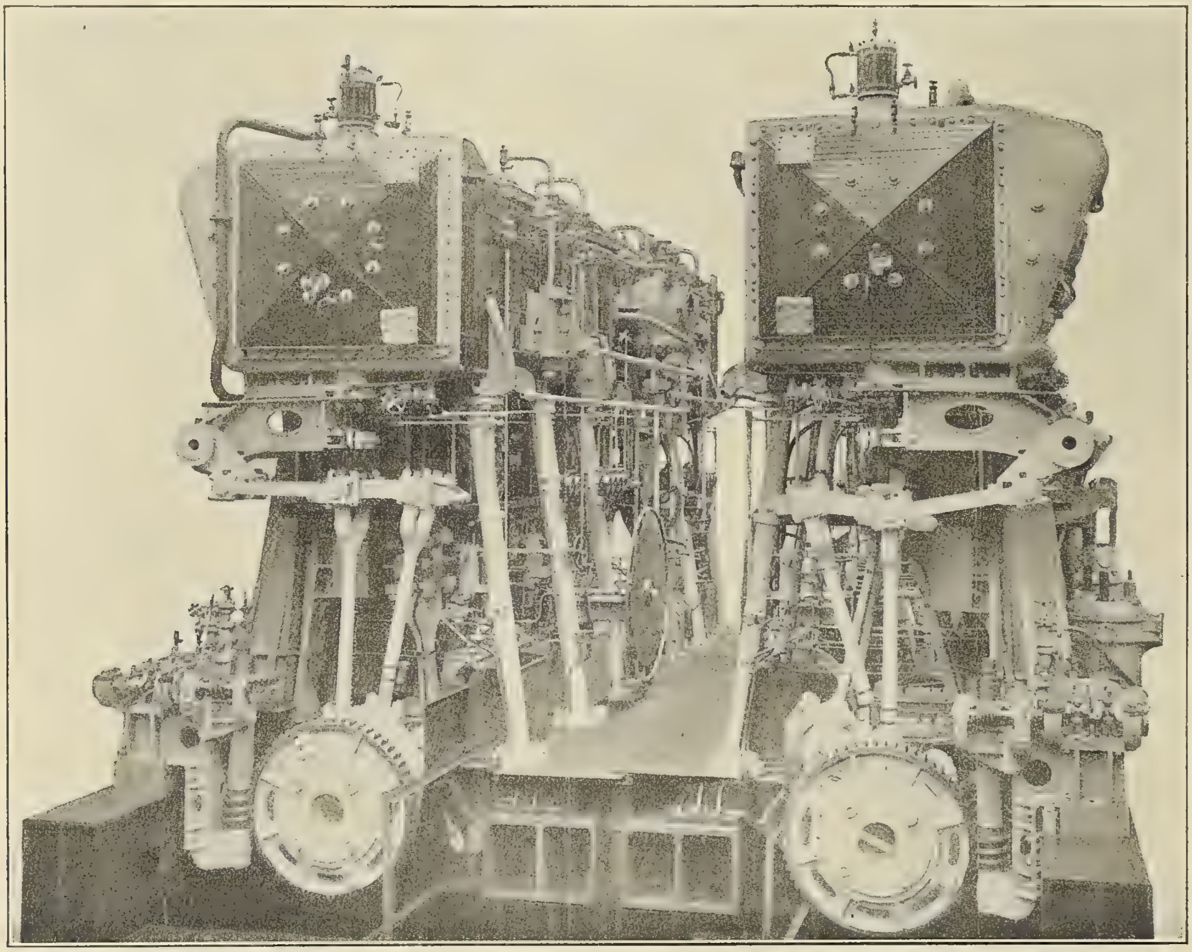
L the length at the W. L. in feet,

B the breadth molded in feet,

V_0 the speed in knots, and

A_0 a coefficient which may be assumed from *25.5* to *26*, for iron ships with bottoms clean and well painted, from *26.5* to *27* for iron ships with copper or zinc sheathing.

(To be continued.)



ENGINES OF THE BRITISH BATTLESHIP DOMINION, WHICH, ON TRIAL, DEVELOPED 18,438, AT 19.5 KNOTS SPEED.

Steam Trials of H. M. S. Dominion.

The first-class battleship *Dominion,* built for the British navy by Messrs. Vickers Sons and Maxim, Limited, at their naval construction works at Barrow-in-Furness, and supplied with her armor and armament from the same company's Sheffield works, completed recently the steam trials prescribed by contract. The results from every point of view were thoroughly successful. The speed attained at full power was, on a deep-sea course, 19.5 knots—one nautical mile per hour greater than was anticipated in the design; so that, excepting the *Triumph* and *Swiftsure,* she is the fastest battleship in the fleet, which, in view of her 16,400 tons displacement, and her powerful primary armament—four 12-inch and four 9.2-inch guns—is specially satisfactory. The power realized was 18,438 indicated horse power—438 indicated horse power over the contract requirement—notwithstanding that the machinery was worked under war conditions, with closed-in engine room and other restrictions, never before exacted on contract tests. The coal consumption at full power was 1.77 pounds per indicated horse power per hour for all purposes, while the water consumption for the main engines—17.3 pounds per horse-power hour—showed a satisfactory efficiency. If to these indications of success there be added the fact that the trials, themselves of 68 hours' duration, were carried out in four days, it will be conceded that the builders have once more proved their great ability.

The *Dominion* belongs to the *King Edward VII.* class, and has a length between perpendiculars of 425 feet, a beam of 77 feet 9 inches, and a depth molded of 42 feet 11 inches. At a draft of 26 feet 9 inches she displaces 16,400 tons. She has a belt, extending from the after armored bulkhead forward to the ram, 9 inches in thickness for the greater part of the length, reduced in three stages at the forward end to 2 inches. The maximum thickness extends along the citadel from 5 feet below the load line to about 3 feet above it; the next strake is 8 inches, and the top strake 7 inches, the latter reaching to the upper deck. The 12-inch guns are in barbettes of 12-inch armor, with hoods having sloping sides. The 9.2 guns are mounted separately in turrets of 7-inch armor on the upper deck, one at each quarter. The 6-inch guns are mounted within the 7-inch broadside armor in a concentrated casemate, as introduced first by the Vickers Company in the *Mikasa.* These 6-inch guns, five on each broadside, are on the main deck of 2-inch armor, while the upper deck is of 1-inch. On convenient positions for defense against torpedo-boat attack are fourteen 12-pounders, fourteen 3-pounders, and two Maxims. The armament includes also four submerged tubes for firing torpedoes.

Military tops have been dispensed with; but on the masts there have been constructed large observation stations which will carry Barr and Stroud range finders, and from these stations the guns will be trained and directed. The after navigating bridge has been abolished, although towers for search lights still remain.

There is, however, an admiral's bridge immediately abaft the main navigating station—a feature more usual on foreign war ships. As to ventilating cowls, the sails tried a year or two ago have been discarded, and the shafts to stoke holds, etc., are now fitted with mushroom-shaped covers, which can be raised and rotated on roller bearings. For the boat derrick on the main mast, vertical hydraulic engines are now substituted for the horizontal machines, not only because they require less deck room, but they are more efficient. The conning tower is larger; steam heating pipes and radiators are laid throughout the habitable quarters; baths are provided for all classes, and more attention has been paid to mechanical ventilation, especially in 'tween decks, as no port holes are possible in the armored sides of the vessel.

The engines are, as has been the case in battleships built since the *Duncan* class, ordered in 1898, of the cruiser type, with four cylinders arranged on the Yarrow-Schlick-Tweedy system. The high-pressure and intermediate cylinders, respectively 33 1-2 inches and 54 1-2 inches in diameter, have piston valves, and the two low-pressure cylinders at the fore-and-aft end of the sets are 63 inches in diameter, with double ported flat valves. These have balancing rings, and throughout the trials a vacuum of 20 inches was maintained behind them. The stroke of the engines is 48 inches, and the connecting rods are 8-foot centers. The ordinary double eccentric link motion is applied, the reversing gear being of the all-round type common to naval work, with a double-cylinder steam engine. All working parts are of forged steel, the crank shafts being 17 1-2 inches in diameter, with a 9-inch hole, the thrust and line shafts 17 inches, with a 9 1-2-inch hole, and the propeller shafts 20 1-2 inches with an 11 1-2-inch hole. The propellers, which are entirely of bronze, have four blades of 17 feet 6 inches diameter, with a pitch on trial of 18 feet 6 inches, and a developed surface of 86 square feet. All auxiliary machinery is independently driven, excepting the air pumps, which are two in number for each set of main engines, driven from the intermediate and high-pressure crossheads. There are four main condensers, with a total cooling surface of 19,000 square feet. The other auxiliary appliances include four evaporators, with an output collectively of 180 tons per 24 hours, and two distillers, having a total cooling surface of 107 square feet, to provide 45 tons of fresh water per 24 hours.

The boilers are of the Babcock and Wilcox type, sixteen in number, with 3 1-2-inch tubes, the total heating surface being 47,369 square feet, and the grate area 1402.5 square feet. There are four fire doors to each boiler, and as there are three boilers in a row in the aft and midship stoke holds, there are twelve furnace doors to be fired, the interval being three to five minutes. The firing was done only through one door in each boiler successively, so that the interval of renewing any portion of the fire in each boiler was five minutes. The cleaning of each section of the fire was at regular intervals of two hours, so that the entire grate in each boiler was cleaned every eight hours. Regularity in stoking and cleaning was ensured by clocks at each boiler, having an outer disc divided into sections to suit the intervals of firing—36 per hour. There is no steam-reducing valve. The feed pumps are located in each stoke hold and the water for the main engines was measured in a series of four tanks placed temporarily on the upper deck, independent tanks being provided for the auxiliary service. As shown in the table of results, the water consumption per indicated horse power per hour in the main engines was, on the 30 hours' trial at one-fifth power, 16 pounds; at 75 per cent. power, 16.6 pounds; and at full power, 17.3 pounds. When the auxiliary engines are included, there is apparently less economy at the lower powers; but this is due to the fact that then the auxiliaries are proportionately of much greater power to the total indicated horse power than when the engines are working at their highest speed. This same remark applies to the loss of water, which, on the higher power trials, was from 3 to 4 tons per 1,000 indicated horse power per 24 hours. This, however, had to be made up by the distillers, and the coal consumption is debited accordingly.—*London Engineering.*

STEAM TRIALS OF H.M.S. DOMINION.

Date of trial	October 28 and 29.		October 29, 30, 31.		November 1.	
Nature of trial	30 hours at 3,600 indicated horse-power.		30 hours at 12,000 indicated horse-power.		8 hours at 18,000 indicated horse-power.	
	Forward	Aft.	Forward	Aft.	Forward	Aft.
Draft of water	26 ft. 1 in.	26 ft. 8 in.	26 ft. 5¾ in.	26 ft. 11½ in.	26 ft.	27 ft. 3 in.
Speed of ship	By log. 12.8 knots.		By log, 18.3 knots.		19.5 knots, measured course.	
Steam pressure in boilers	241.3 lb. per sq. in.		243.8 lb. per sq. in.		248.1 lb. per sq. in.	
Air pressure in stokeholds	Nil.		$\frac{1}{10}$		$\frac{9}{20}$	
	Starboard.	Port.	Starboard.	Port.	Starboard.	Port.
Vacuum in condensers	26.5	26.3	26.5	26.2	26.5	25.6
Revolutions per minute	78.3	77.5	113.9	113.7	125.8	125.5
Mean pressure in receivers: High	124.6	124.5	200.6	198.8	228 1	227.5
Mean pressure in receivers: Intermediate	26.6	25.5	64.5	61.6	84.3	83.1
Mean pressure in receivers: Low	1.6	1.9	11.0	11.4	21.7	21.0
Mean pressure in cylinders: High	35.5	38.0	79.5	80.1	90.7	91.5
Mean pressure in cylinders: Intermediate	14.9	14.4	33.9	32.7	40.6	41.3
Mean pressure in cylinders: Low forward	6.57	6.21	13 06	13 6	19.6	19.3
Mean pressure in cylinders: Low aft	6.18	4.89	14.2	13.3	22.0	20.6
Mean indicated horse-power: High	561	630	1,934	1,945	2,434	2,453
Mean indicated horse-power: Intermediate	660	631	2,186	2,108	2,885	2,934
Mean indicated horse-power: Low forward	390	364	1,125	1,174	1,865	1.831
Mean indicated horse-power: Low aft	366	287	1,223	1,148	2,086	1,949
Total	1,977	1,912	6,468	6,375	9,270	9,168
Grand total	3,889		12,843		18,438	
Consumption of coal per indicated horse-power per hour	1.93 lb.		1.68 lb.		1.77 lb.	
Total loss of water per 1,000 indicated horse-power per 24 hours	5.34 tons		3.04 tons		3.38 tons	
Water consumption per I. H. P. per hour: Main engines	16.6 lb.		16 lb.		17.3 lb.	
Water consumption per I. H. P. per hour: All purposes	21.6 "		18.4		18.3 "	

German Merchant Marine.—On April 1, 1904, the German empire possessed 1,011 ships, of an average capacity of over 1,000 tons each, against 976 ships of 1,000 tons in 1903. Of these ships, 786 were steamers and 225 sailing vessels. The increase in number occurred in steamers. To-day Germany has only 10 fast steamers; four, the *Fürst Bismarck, Augusta Victoria, Columbia,* and *Kaiserin Maria Teresa,* have been sold to Russia. Of the foregoing, 38 steamers carried the post; the others were passenger and freight steamers. In regard to size, the *Kaiser Wilhelm II.,* of the North German Lloyd, with its 20,000 tons, led. There are two steamers now in course of construction for the Hamburg-American line which will be even larger than the *Kaiser Wilhelm II.* One of these, the *America,* is being built in Ireland, and the other, the *Europa,* in the ship yard of Stettin. Of the number of ships in the Hamburg-American line there are 128 steamers. The North German Lloyd has 97 steamers; the Hansa, in Bremen, 42; the German Levant line, 30; the Wormann line, 29; the Hamburg-South American Steamship Company, 28; the Cosmos, 26, and the German-Australian Steamship Company, 25. There were 47 new steamers in course of construction in April, 1904. Of these, 13 were for the Hamburg-American line, 3 for the North German Lloyd, 6 for the Hansa, and 7 for the firm of H. C. Hahn and Schleswig. In the matter of sailing vessels, it is noticeable that the number is not increasing, but that there is a tendency to increase their tonnage capacity.—*United States Consular Report.*

COAST AND GEODETIC SURVEY STEAMER PATHFINDER.

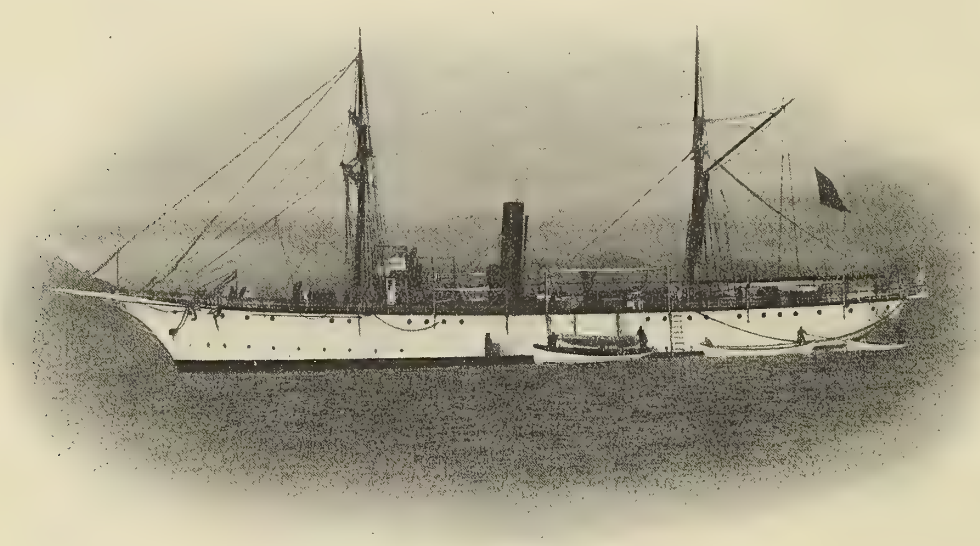
The *Pathfinder* was built at the Crescent Shipyard, Elizabethport, N. J., while Dr. Henry S. Pritchett was superintendent of the Coast and Geodetic Survey. She was launched on December 7, 1898, put in commission on April 23, 1899, and sailed for San Francisco, Cal., on June 7, arriving there September 18, 1899. The vessel is a steel, single-screw steamer, rigged as a brigantine with short bowsprit, and has a sail area of 4,478 square feet, sufficient to give her steerage way in a moderate breeze. She is fitted with bilge keels. The general dimensions are:

Length on water line at 10 feet draft	165 ft.
Length over all	193 ft.
Breadth of beam	33 ft. 6 ins.
Depth from top of flat keel plate to top of spar deck beams	19 ft. 8 ins.
Displacement at 10-foot water line	875 tons
Registered tonnage (gross)	690 tons
Registered tonnage (net)	469 tons

The spar deck stringers are of 15 and 10-pound plate, the main deck stringers of 10 and 8 1-2-pound plate, and the berth deck stringers and plating of 8 1-2 and 5-pound plate.

The spar deck beams, spaced 24 inches, and with a crown of 7 1-2 inches in 31 feet, are 3 by 5-inch angle bars secured to the frames by brackets of 10-pound plates. The main deck beams are straight; in the engine and boiler space they are 3 by 6-inch angle bulb, and forward and abaft this space 3 by 5-inch angle bars spaced 48 inches, except at mast partners, hatches, and bulkheads, where they are spaced 24 inches; they are secured to the frames by brackets of 8 1-2-pound plate. The berth deck beams are straight, spaced 48 inches, and of 3 by 4 1-2-inch angle bars, secured to the frames by brackets of 8 1-2-pound plate. The top of these beams is 7 feet below the top of the main deck beams at the center line of the vessel.

The spar and main decks are of 3 by 3-inch yellow pine, and the berth deck is laid with 2 1-2 by 4-inch yellow pine on top of 8-pound steel plates which are water tight. All hatch coamings are steel, and the berth deck hatches are plate steel and water tight when closed.



THE PATHFINDER, THE COAST AND GEODETIC SURVEY STEAMER, NOW IN THE PHILIPPINES.

The stem is of wrought iron 7 by 2 3-4 inches, and the stern post is of wrought iron 8 by 5 inches. The flat keel plate is of 20-pound steel and the vertical keel of 15-pound plate and 21 inches deep; the frames, spaced 24 inches, are Z bars 3 by 3 by 5 inches; the forward and after 12 frames being 3 by 5-inch angle bars. There are three longitudinals on each side—the first is continuous and water tight, under the engine and boiler space, and the other two on each side are intercostal of 10 and 12 1-2-pound plates.

The flat keelson plate, of 12 1-2 pounds, extends from frame 5 to frame 75; under the engine and boiler space it forms the top of the water tank, or double bottom, between the first intercostals; forward and aft this water tank the flat keelson plate is 9 inches in width on each side of the vertical keel.

The outside plating is of 15 pounds doubled at the water line forward and with an additional sheer strake of 15 pounds for a distance of 100 feet admiships; the horizontal seams are lapped and single riveted, the vertical seams are butted and double riveted. The lower courses of the thwartship bulkheads and coal bunkers are of 10 pounds and the upper course of 7 1-2 pounds steel plates stiffened by 2 by 3 inches and 2 1-2 by 3-inch angle bars of 4 and 6 pounds respectively, spaced 24 inches.

MACHINERY.

The machinery consists of a vertical, three-cylinder, triple-expansion engine 18, 27, and 44 inches and 28 inches stroke, driving a four-bladed screw 10 feet in diameter and 13 feet pitch. On the trial trip the indicated horse power was 847 with natural draft and 1,173 with forced draft. Under natural draft, with a steam pressure of 144 pounds and 115 revolutions, the speed was 12.4 knots, and under forced draft, with a steam pressure of 160.6 pounds and 121 revolutions, the speed was 13.4 knots. At a cruising speed of 10 knots the coal consumption is 11 tons in 24 hours.

The auxiliary machinery consists of a steam windlass and capstan, steam steerer, steam boat-hoisting winch, ice-making machine, two dynamos, bilge, fire, feed, and sanitary pumps, and an evaporator and distiller with a capacity of 1,600 gallons of fresh water per 24 hours.

There are two Scotch boilers each 11 feet long and 11 feet 1 inch in diameter, each with two corrugated furnaces; the combined grate surface is 90 square feet and heating surface 2,834 square feet. The boilers are tested for a working pressure of 165 pounds. One vertical donkey boiler 10 feet high and 5 feet in diameter with a grate surface of 15 1-2 square feet and heating surface of 574 square feet. The two main boilers are placed side

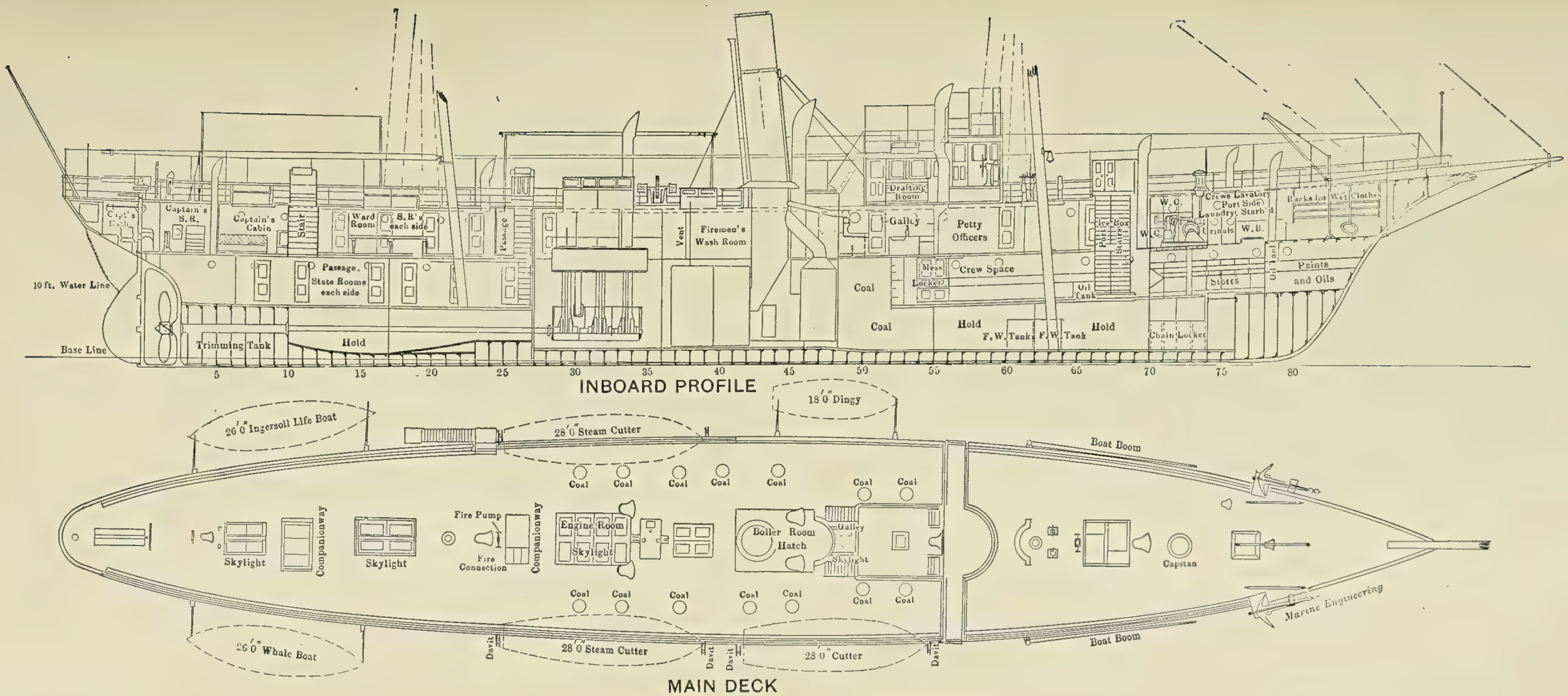


FIG. 2.—PLANS OF THE COAST AND GEODETIC SURVEY STEAMER PATHFINDER.

by side and fired from forward end. The capacity of the bunkers is 230 tons, which, at a speed of 10 knots, gives the vessel a steaming radius of 5,000 miles.

ARRANGEMENT.

The general arrangement is shown in Fig. 2 of the longitudinal and upper deck plans. Below the berth deck are two trimming tanks—one at each end of the vessel—and five thwartship water tight bulkheads, making five water tight compartments (holds). The five thwartship water tight bulkheads extend to the main deck and three of them to the spar deck. The fore-and-aft coal bunker bulkheads are also water tight.

The berth deck forward is taken up by a paint and oil locker abaft of which is the general (boatswain's) store room and brig. From the store room for a distance of 36 feet aft and the full width of the ship are crew berthing space and messing space for fifty men, allowing 100 cubic feet of space per man. On the berth deck aft are four state rooms, with six berths for junior officers; also eight state rooms and a sail room, with a passage leading fore-and-aft between them.

On the main deck forward of the water tight bulkhead for a distance of 30 feet to the bow are the lamp room, laundry, crew's lavatory, water closets, and the steam windlass; abaft this bulkhead for a distance of 42 feet to the fire room bulkhead (water tight) on the starboard side are the carpenters' tool room and four state rooms with a berthing capacity of ten petty officers; on the port side is the ice machine and refrigerator, office, sick bay with two berths, dispensary, petty officers' pantry, and photographer's dark room; at the after end, amidships, is the galley. The open space amidships on the main deck has hammock berthing for 26 men and is the mess room for the petty officers. On the main deck aft, just forward of the engine room bulkhead on the starboard side, are the dynamo room and engineers' tool and work room, and on the port side is the officers' water closet. Abaft the engine room bulkhead, abreast the ward room companionway on the starboard side, is the ward room pantry, and on the port side the ward room bath room. Abaft these is the ward room with eight state rooms, and abreast the cabin companionway is the captain's pantry, abaft of which is the cabin with two state rooms, toilet, and bath.

The engine, boilers, coal bunkers, dynamo room, fireman's wash room, and tool room occupy a space of 40 feet in length and the full height between decks to the spar deck, with 10 additional feet for coal bunkers under the berth deck.

SHIP'S OUTFIT AND STORES.

The ship's outfit of boats consists of two 28-foot steam launches, two 26-foot whaleboats, one 26-foot cutter, one 18-foot dinghy, and room for carrying a number of skiffs on deck. All the boats are rigged to be carried on the deck or the rail if required.

The vessel is lighted by electricity throughout and has a search light on the bridge; in the tropics electric fans are used for ventilation. There is a complete installation for heating the vessel by steam, this being necessary for the health and comfort of the ship's company when working in Alaskan waters.

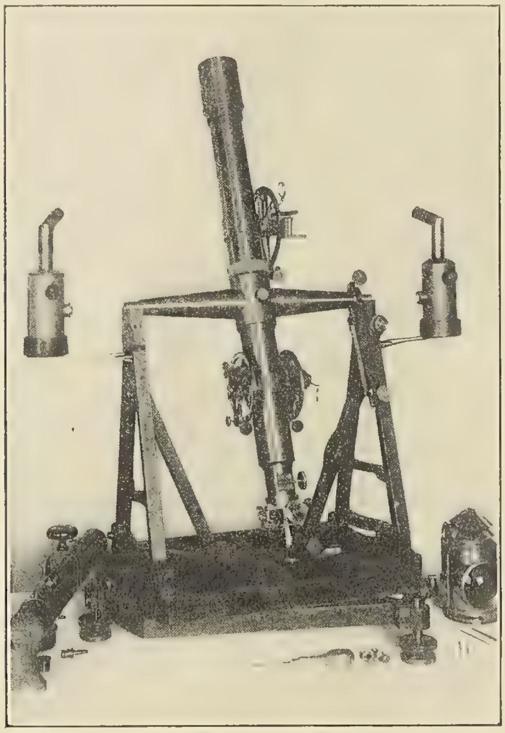


FIG. 3.—MERIDIAN TELESCOPE.

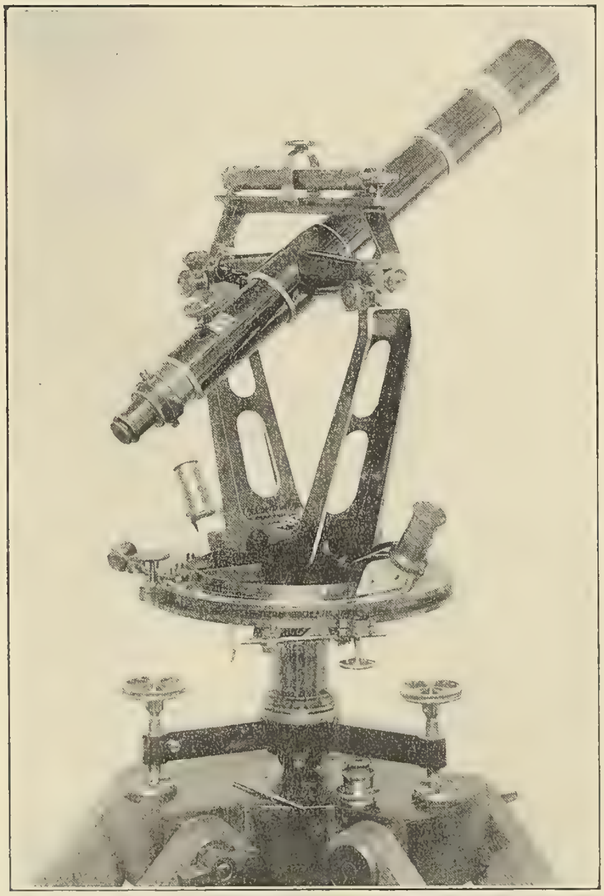


FIG. 4.—6-INCH GAMBEY THEODOLITE.

The water tanks have a capacity of 3,000 gallons, not including the tank under the engine room and boiler space, which has a capacity of 3,000 gallons. There are several spare propeller blades and spare parts of machinery which are most liable to be required in a long cruise. Ship's supplies, clothing, small stores, and provisions for 16 officers and a crew of 70 men for a six months' cruise can be stored in the holds and store rooms.

SURVEYING OUTFIT.

The outfit of surveying instruments includes eight mean time chronometers and two sidereal time chronometers, together with a meridian telescope for the astronomical determinations of azimuth latitude and longitude; three theodolites for triangulation; base measuring tapes with thermometers and spring scales;

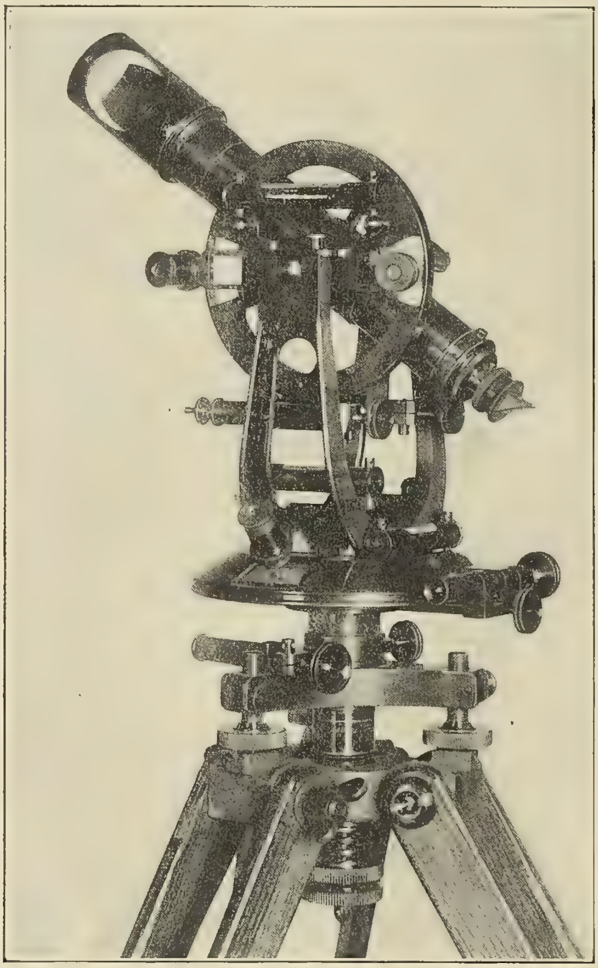


FIG. 5.—4-INCH THEODOLITE.

engineers' Y level; magnetometer; ordinary dip circle, and Creag dip circle with binnacle stand and compass for magnetic observations at sea; plane tables for topographical work; a complete outfit for topographic photography; sounding machines for deep sea and inshore hydrography; a channel sweep for finding small obstructions to a depth of 35 feet below the surface of the water; a marine sentry for use in unknown deep waters to give indications of rocks and shoals with a limited depth of water over them, and a complete outfit of instruments for the investigation of water temperatures and densities.

The sounding machines include a Sigsbee machine, a Lord Kelvin machine, three Tanner machines—two of the latter being fitted for use in boats; all of these have been in use for a number of years and have earned a high reputation for their satisfactory work. The Sigsbee machine, which is used for the greatest depths, is mounted on a platform over the stern of the vessel and far enough aft to prevent the sounding wire from fouling the screw. The machine has a record of sounding in over 5,000 fathoms of water. The Lord Kelvin machine is mounted on the starboard quarter, and is used in depths of 100 fathoms or less while the vessel is under way and running at any speed. The Tanner machine can be mounted wherever found

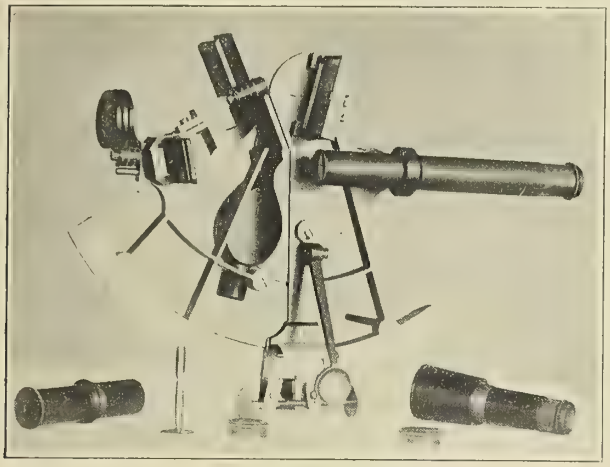


FIG. 6.—NAVIGATION SEXTANT.

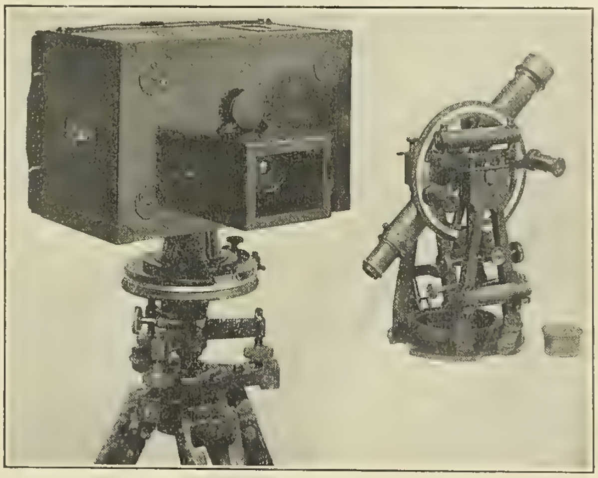


FIG. 8.—PHOTO-TOPOGRAPHIC CAMERA.

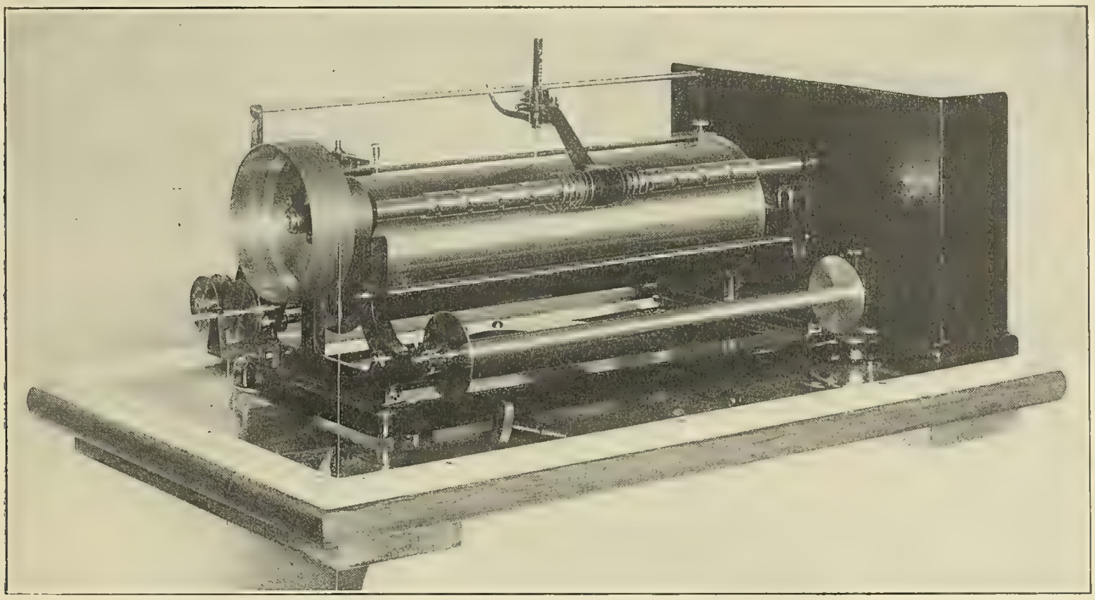


FIG. 9.—SELF-REGISTERING TIDE GAUGE.

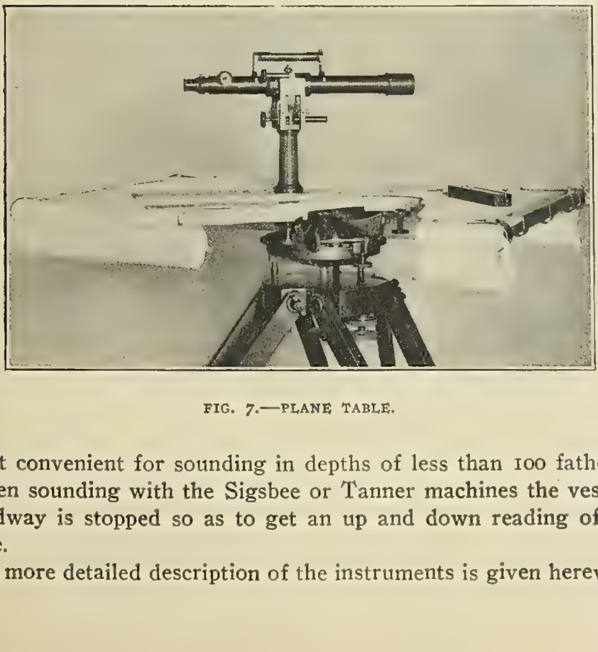


FIG. 7.—PLANE TABLE.

most convenient for sounding in depths of less than 100 fathoms. When sounding with the Sigsbee or Tanner machines the vessel's headway is stopped so as to get an up and down reading of the wire.

A more detailed description of the instruments is given herewith, with several illustrations, from which it will be seen the broad scope of work that the *Pathfinder* is designed for, as well as her extensive equipment.

Meridian Telescope. Fig. 3. For determining time (longitudinal), latitude, and azimuth. In beginning the survey of the Philippine islands a large number of geographic positions were determined astronomically at the shore terminals of the cable lines, many cables having been laid by the army incidental to the military operations. These positions served as initial points, or base stations, for extending the surveys in all directions.

Six-inch Gambey Repeating Circle. Fig. 4. Remodeled by the Coast and Geodetic Survey. A base line having been measured with a steel tape in the vicinity of one of the initial points, a triangulation is extended in the neighborhood, and in many cases reaches the shores of other islands. This instrument would be used in observing the angles, or in case of very long lines between the stations one of the larger ones in the cuts following.

Seven-inch Theodolite, for secondary triangulation and determination of time, latitude, and azimuth in difficult country and in rough mountainous country where the weight and bulk of the instrument is a consideration in transportation.

Ten-inch Repeating Theodolite, for triangulation and determination of azimuth.

Four-inch Theodolite. Fig. 5. For reconnoissance and tertiary triangulation.

Navigation Sextant, or Astronomical Sextant. Fig. 6. This well-known instrument is used in determining the position of the ship at sea by astronomical observations for purposes of navigation, and the more elaborate observations that may be taken in running deep-sea sounding lines.

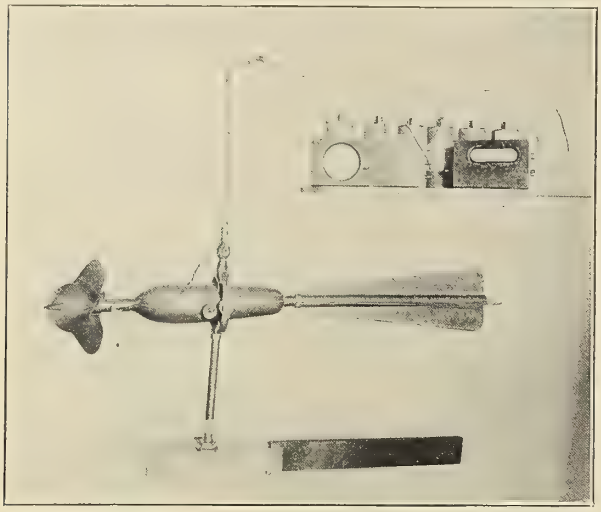


FIG. 10.—DEEP-SEA DIRECTION AND VELOCITY CURRENT METER.

The Plane Table. Fig. 7. Coast and Geodetic Survey form. After the triangulation has covered the ground, the shore line and topographical details, such as roads, houses, hills, etc., are developed with this instrument. In many cases where the survey may be desired immediately, a graphic triangulation is made with the plane table instead of waiting for the more precise work with the theodolite, the plane table stations being marked so that they may be recovered and included in the precise work when it shall be obtained.

Survey Photo-Topographic Camera. Fig. 8. Coast and Geodetic Survey type. This is a useful auxiliary to the plane table, theodolite, or transit, particularly in a mountainous country.

Self-Registering Tide Gauge, Stierle Form. Fig. 9. Improved by the Coast and Geodetic Survey. Soundings are taken at any stage of the tide and must be reduced to a common plane to be available for chart publication. The tide gauge records the water as it rises and falls, and if the observations are continued for a sufficient period they will furnish the data by which the

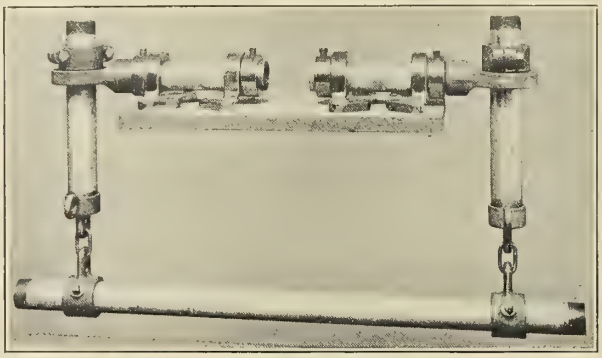


FIG. 12.—HARBOR AND CHANNEL SWEEP.

time of the rise and fall can be predicted for several years ahead. Simultaneous observations on gauges at other places permit the predictions to be extended to those places, so that eventually from a few primary stations at which a long series has been observed, and numerous subsidary stations observed for short periods, tide tables can be constructed for all parts of the islands. The central drum is driven by a clock shown at the right in the illustration, while the shaft with pencil is revolved by floats by the raising or falling of the tide.

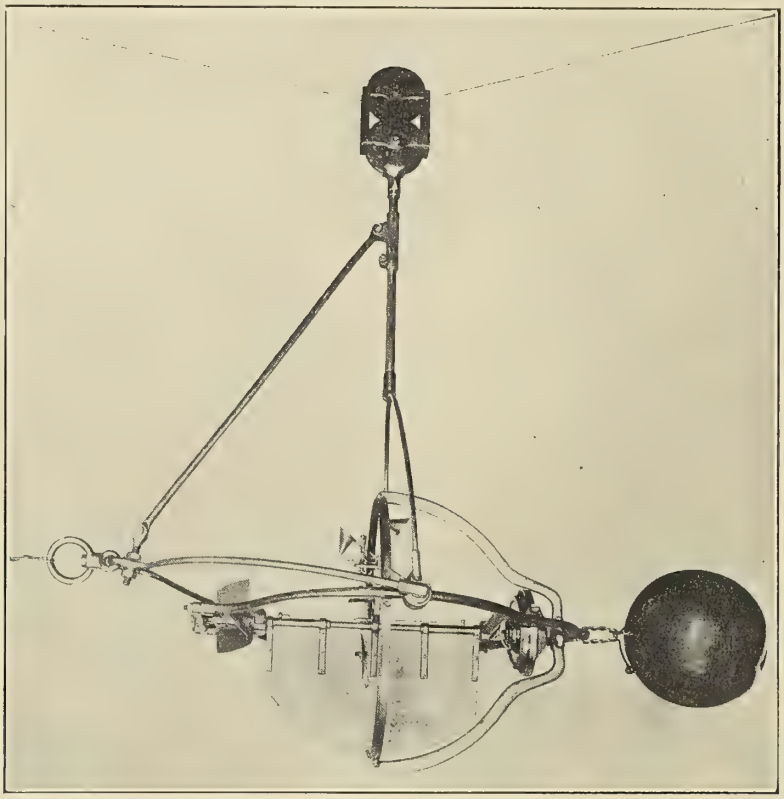


FIG. 11.—PILLSBURY DEEP-SEA METER.

Ritchie and Haskell Deep-Sea Direction and Velocity Meter. Fig. 10. The meter holds a compass within its body that is connected electrically with a compass on the ship; the turns of the propeller are also recorded electrically on the ship. Therefore, when the meter is lowered in the water the direction or compass course to which it points and the speed of the propeller are known on the vessel at all times. This meter is used to determine surface currents with only a slight difference in the arrangement of the tow lines.

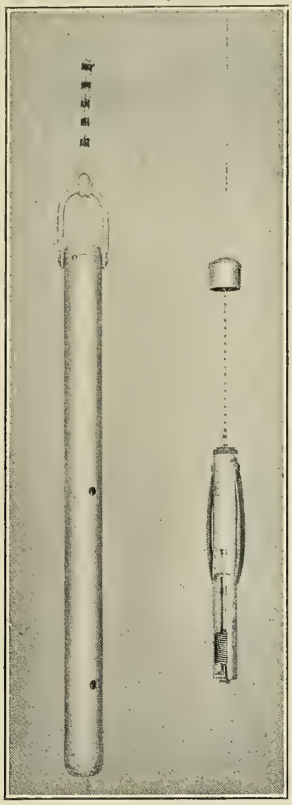


FIG. 13.—LORD KELVIN DEPTH RECORDER.

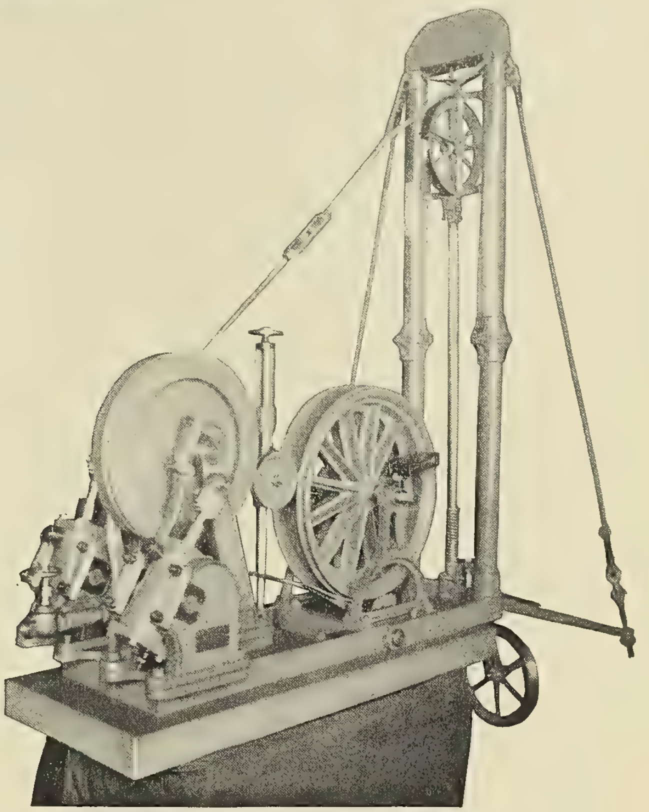
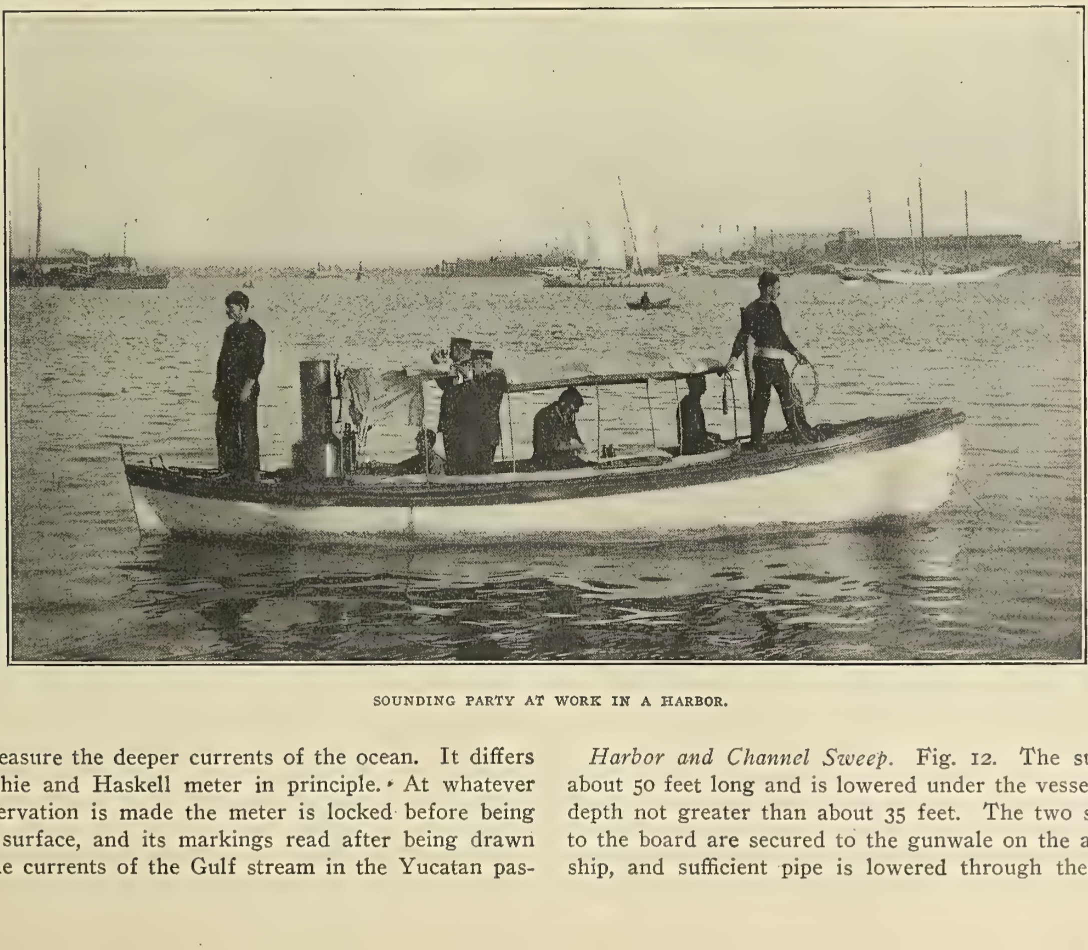


FIG. 14.—SIGSBEE DEEP-SEA SOUNDING MACHINE.

Pillsbury Deep-Sea Current Meter. Fig. 11. This meter was designed to measure the deeper currents of the ocean. It differs from the Ritchie and Haskell meter in principle. At whatever depth the observation is made the meter is locked before being drawn to the surface, and its markings read after being drawn on board. The currents of the Gulf stream in the Yucatan passage, off Key West, and across from Fowey rocks were measured with this meter.



SOUNDING PARTY AT WORK IN A HARBOR.

Bliss Taffrail Log. The propeller is dragged astern of the vessel and registers the speed of the ship in proportion to the turns of the propeller.

Harbor and Channel Sweep. Fig. 12. The suspended bar is about 50 feet long and is lowered under the vessel to any desired depth not greater than about 35 feet. The two swivels fastened to the board are secured to the gunwale on the after part of the ship, and sufficient pipe is lowered through them to make the desired depth. The piping is maintained perpendicularly by guys leading forward that can be readily cast off when the bar strikes an obstruction. The two links are made to break at a fixed strain to prevent tearing the apparatus to pieces. This apparatus increases the draft of the ship to any desired figure less than about 35 feet, and is used to determine how great a draft can be carried through a given channel without obstruction, or to find isolated rocks that have been reported or may be suspected to exist in a channel or harbor.

Sir William Thompson's (Lord Kelvin) Depth Recorder. Fig. 13. A device that determines the depth to about 80 or 90 fathoms without stopping the ship's headway to take a sounding. In this instrument the weight of the water compresses a spring; other devices similar in principle compress the air in a glass tube by which the depth is deduced. Their application is limited to less than 100 fathoms.

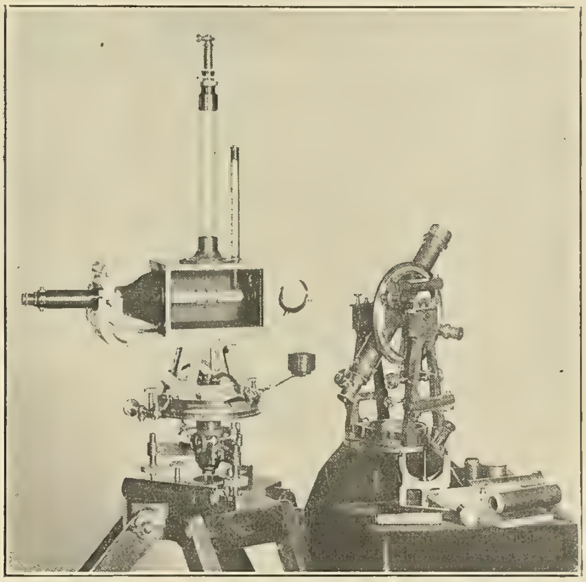


FIG. 15.—MAGNETOMETER. FOR DETERMINING MAGNETIC DECLINATION AND INTENSITY.

Sigsbee Deep-Sea Sounding Machine. Fig. 14. This machine has been used very successfully in securing soundings at very great depths as well as in lesser depths. The sounding line is piano wire to which a shot is attached by a simple device that detaches the shot when bottom is reached. A specimen cup is also attached to the sounding wire and slips through the shot when the latter is detached; bottom has been brought up in this cup from a depth of five miles. The machine has been used for developing the deeper depths of the oceans and for lines of "cable sounding."

The machine is constructed so as to lessen the strain on the sounding line from the rolling of the ship when the shot is at great depth.

Cosmos Boat Sounding Machine. This machine was devised on the Coast and Geodetic Survey launch *Cosmos,* and is well adapted to use on a launch for soundings of less than 500 fathoms. It consists of two geared wheels, one driven by a pair of handles and the other carrying a drum for winding the sounding wire. Its main advantages are the use of a light lead and quick recovery of the sounding wire; it reels in three fathoms with one turn of the crank handles.

Hydrographic Sextant. This instrument differs from the navigation or astronomical sextent in being much smaller and lighter, and that it reads only to half minutes.

Three-Arm Protractor. The position of the sounding boat is determined at frequent intervals by measuring two angles simultaneously with the sextant between three known positions on shore; these angles are then laid off on the protractor and plotted by the points on the sheet to which they were measured. The protractor shows the extension arms that may be added to make a longer reach.

Magnetometer. Fig. 15. For determining magnetic declination and intensity.

Dip Circle. Fig. 16. For determining dip of the needle, and, with the aid of compass mounted on top, also declination and intensity. The determination of the magnetic elements is a very essential feature of a survey for constructing a chart. A number of magentic observatories have been established in the United States and occupied for a series of years to determine these elements and their annual changes, and recently observations have been made by the ships on the ocean for the same purpose with such success that valuable results are expected in the future.

Since the *Pathfinder* has been in commission she has spent a winter season surveying in the Hawaiian islands, two summer seasons in Behring sea, and three years in the waters of the Philippine islands. In the latter waters she has made surveys, including all classes of work, of Romblon harbor, Romblon island, Ormoc harbor, Leyte island, Cebu harbor, Cebu island, San Bernardino strait and approaches from the sea, Albai gulf, east coast of Luzon, San Pedro bay and south coast of Samar island

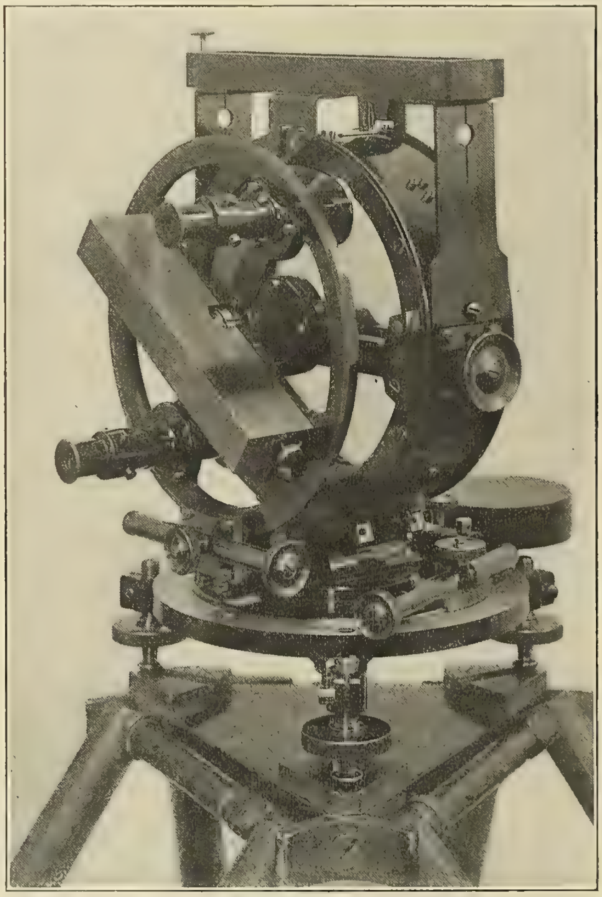


FIG. 16.—DIP CIRCLE FOR DETERMINING DIP OF THE NEEDLE, AND WITH THE AID OF COMPASS MOUNTED ON TOP, ALSO DECLINATION AND INTENSITY.

to Point Sangi, southwest coast of Leyte island from Illegos point to Maasin, Tobaco bay and Lagonoi gulf, east coast of Luzon island, supplementary work in Manila bay in the vicinity of Manila, hydrographic work along the west coast of Luzon island, north of Lingayen gulf, and has run a line of deep-sea soundings from a position off Point Bolinao to a point northeast of the Island of Formosa.

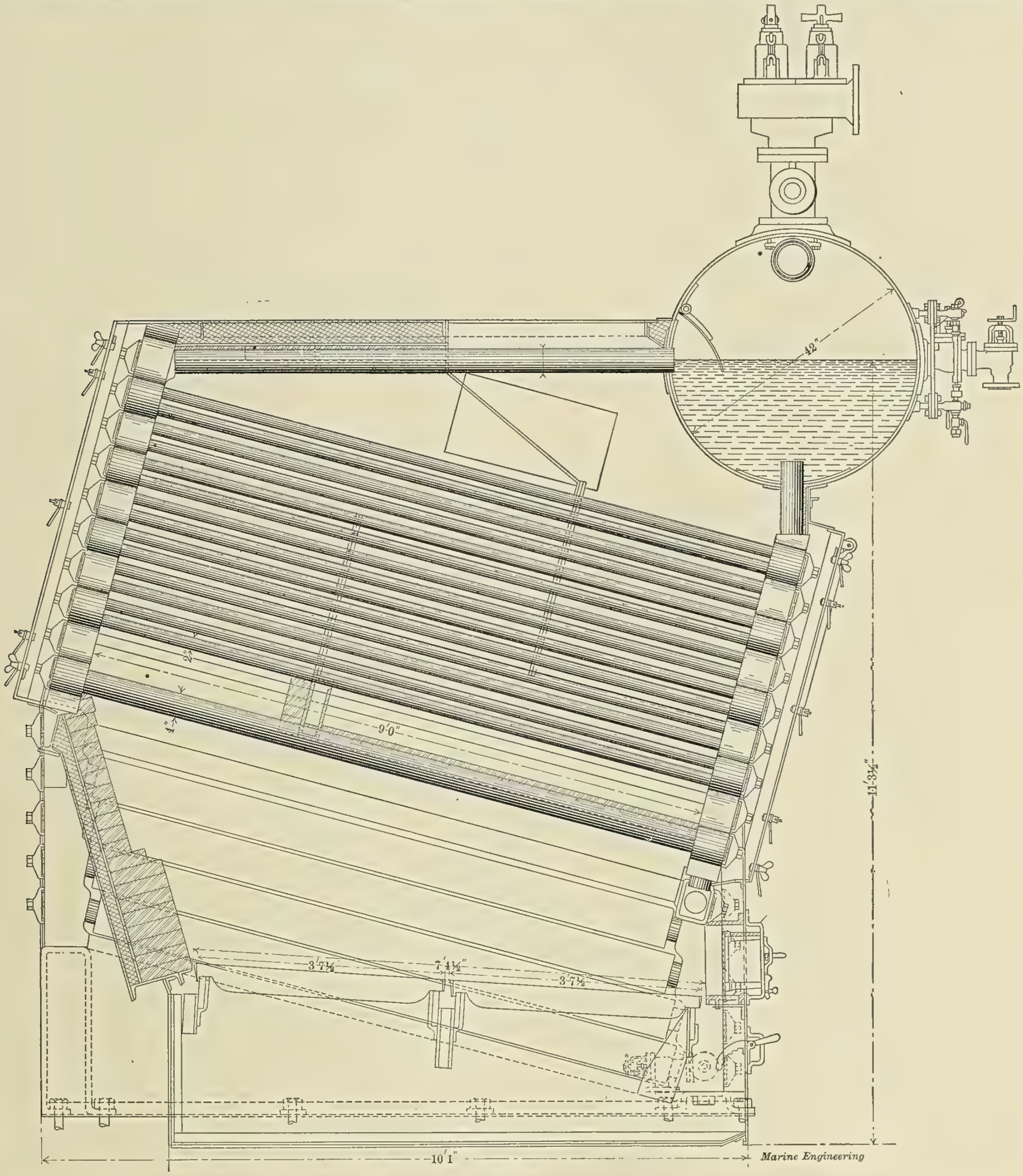
In all this work the *Pathfinder* has proved herself admirably adapted to the work for which she was designed.

FERRYBOATS FOR THE NEW YORK-STATEN ISLAND SERVICE.—III.*

MACHINERY.

The propelling machinery of these boats, now nearing completion, four of which are building by the Maryland Steel Company, and one by the Burlee Dry Dock Company, consists of two sets of inverted direct-acting, compound-surface condensing engines, with cylinders 22 1-2 and 50 inches diameter by 30 inches stroke. The two sets are coupled together with the low-pressure cylinders in the middle with cranks at an angle of 90 degrees. The high-pressures are at the ends with cranks opposite their respective low-pressure cranks. Each cylinder is cast with its steam chest, and each pair is firmly bolted together. The high-pressure cylinders are fitted with liners and one piston valve. The low-pressure cylinders each have two piston valves with separate liners. The cylinders are mounted on cast iron box-section back columns, and at the front are wrought steel columns.

The low-pressure pistons are of cast steel conical dished shape; the high-pressure pistons are of cast iron filled solid with lead. The piston rods are of forged steel, 5 1-2 inches diameter, and the connecting rods, which are 75 inches between centers, are forked at the upper ends, 5 1-2 inches diameter at the top, 6 1-4 inches at the bottom. The double forged steel crosshead pins are 6 1-2 inches diameter by 6 1-2 inches long. The bed plate of each engine is a single iron casting with a distance piece between engines. The crank shaft is 12 1-2 inches diameter, a solid forging for each engine. The crank pins are 12 1-2 by 12 1-2 inches, and the webs 9 1-4 inches thick. The line shaft is 12 inches and the thrust and propeller shafting are 12 and 12 1-2 inches respectively. Reversing is accomplished by a steam gear of the floating lever type, and the reverse shaft is 5 1-2 inches diameter. The valve gear is the Stevenson link type, with double bars 5 inches deep by 1 3-4 inches thick. The link blocks are of forged steel with pins 4 inches diameter by 3 1-4 inches long, and gibs of composition 12 inches long. The eccentric rods are of forged steel, and the straps of cast steel 3 3-4 inches wide lined with white metal. There is a thrust bearing at either end of engine of the usual horseshoe type, and cast iron stern tubes, one at



TYPE OF BABCOCK AND WILCOX WATER-TUBE BOILER TO BE INSTALLED ON THE STATEN ISLAND FERRY.

*Continued from page 474, October, 1904, issue.

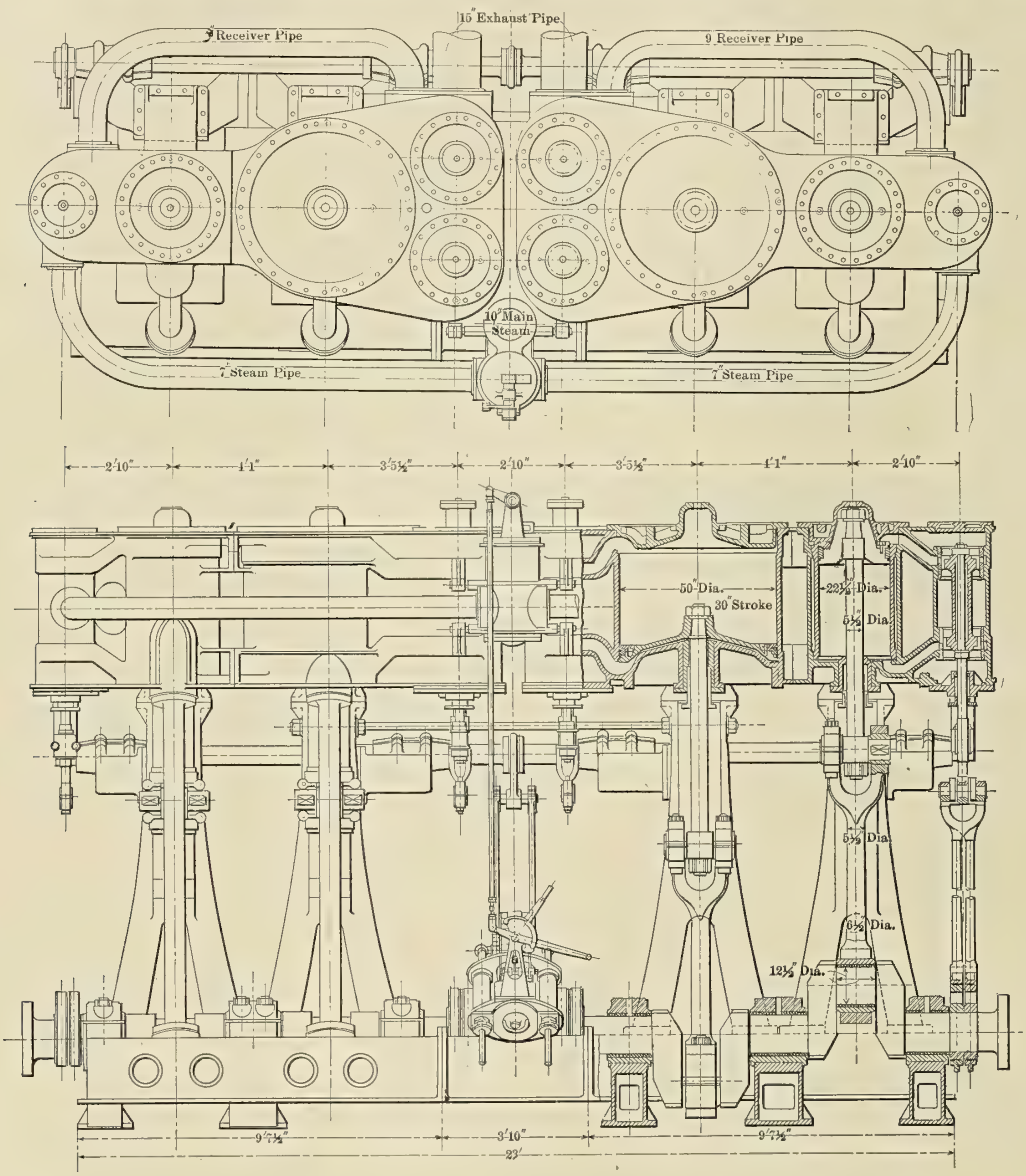
either end of the boat, lined with lignum-vitæ staves. The propellers are to be of open hearth steel 11 feet diameter.

The exhaust from each low-pressure cylinder is led to back of the engine to one main condenser with sheet steel shell; 4,500 square feet of cooling surface, measured on the outside of tubes, is to be provided by 3-4 inch brass tinned tubes No. 18 B. W. G.

There will be one single-acting beam twin independent air pump, 10 and 22 inches by 18 inches. There is one centrifugal circulating pump with 12-inch suction driven by a 9 by 9-inch engine. There will be two main feed pumps of the vertical simplex type, 10 and 6 inches by 12 inches, and two auxiliary feeds 12 and 8 inches by 16 inches. The other pumps include duplex fire and donkey pump, 12 and 9 3-4 inches by 10 inches; a sanitary pump, vertical simplex, 6 and 8 by 8 inches; a fresh water duplex pump, 4 1-2 and 3 3-4 by 4 inches; injectors; bilge syphons, and feed-water heaters. A complete water service and lubricating system is to be fitted.

There are to be four boilers of the Babcock and Wilcox water-tube type in each ship, two placed in each of the fire rooms located at each end of the engine room, with an aggregate grate surface, with 7 feet bars, of 340 square feet, and an aggregate heating surface of 13,000 square feet.

The steam and water drums are 42 inches in diameter, the tubes being 2 inches in diameter, except the row immediately above the fire, which is composed of 4-inch tubes. The tubes are 9 feet long and of seamless cold drawn steel, all pressure parts are of forged steel, and the boilers will operate under 220 pounds pressure and are of the same type as those extensively used in recent United States war ships.



GENERAL ARRANGEMENT PLAN OF THE DOUBLE COMPOUND ENGINES FOR THE STATEN ISLAND FERRYBOATS.

Forced draft is to be provided on the closed stoke hold system by two steel plate fans.

Turbine Steamer Victoria.—The cable despatches reported last month that S. S. *Victoria,* which was equipped with Parsons steam turbines, had proved a great disappointment, so far as speed was concerned. The reporter must have been using his imagination, as we are informed by the Parsons Marine Steam Turbine Company, 97 Cedar street, New York, N. Y., that the turbines have not yet been fitted into the ship, so that there is no truth whatever in the report.

Scout Cruisers for the United States Navy.

Plans for the new scout cruisers, which have been under consideration in the Navy Department for several months, are nearing completion, and it is anticipated that they will be ready for distribution to prospective builders about the latter part of January. The Board of Construction has recommended that the three cruisers which were authorized at the last congress be of the following dimensions:

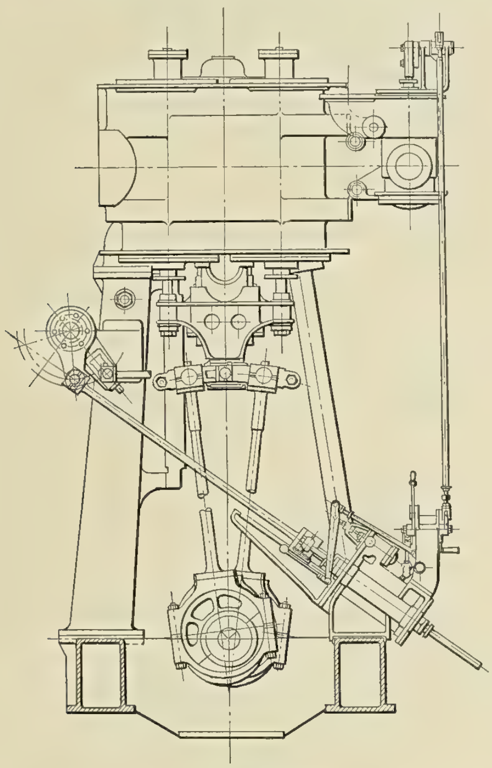
Length, between perpendiculars .... 420 ft.
Breadth .... 46 ft. 8 ins.
Draft, fully loaded .... 16 ft. 3 1-2 ins.
Depth, amidships .... 36 ft. 5 15-16 ins.
Displacement, loaded .... 4,310 tons
Draft on trial .... 16 ft. 10 ins.
Corresponding displacement on trial .... 3,750 tons
Speed .... 24 knots

The battery is to consist of twelve 3-inch guns and two 21-inch submerged torpedo tubes, with 3,600 rounds of the 3-inch ammunition, and 8 torpedoes. The estimated weight of battery and full ammunition is 140 tons. Over the length of machinery space there is to be worked in an inclined nickel steel deck 1 1-2 inches thick, and a vertical steel protection deck 2 inches thick, extending above the tops of the boiler drums and cylinders of the main engines. At each end of the machinery space a thwartship nickel steel bulkhead, 1 inch thick, is to be fitted. Nickel steel armor, 2 inches thick, on the sides and 1 inch on the top, is to afford protection to that part of the steering gear which is above the water line. The total estimated weight of the nickel steel armor is 205 tons.

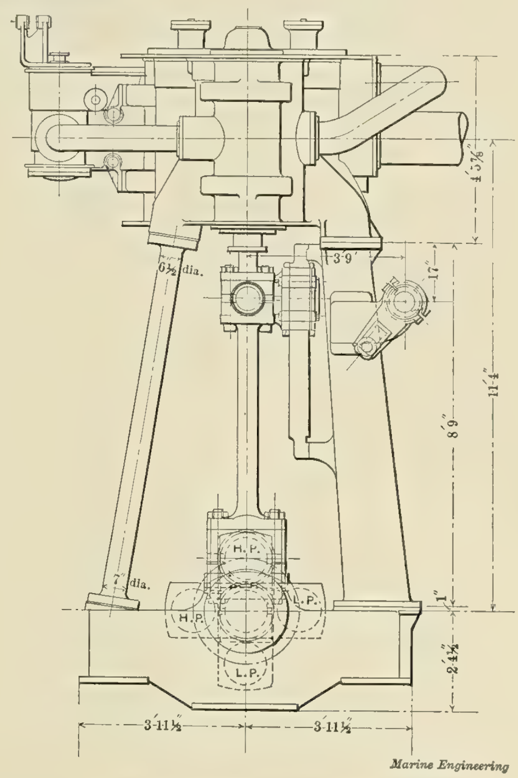
Four endless-chain electric ammunition hoists are to be installed, two forward and two aft, for supplying the ammunition for the 3-inch guns, while for handling the boats and coaling, etc., it is proposed to install four electric deck winches. The anchors are to be handled by one steam capstan windlass, and the steering gear is to be of the usual steam and hand type, with steering stations on the forward bridge and in the steering engine room. The vessel is to be lighted throughout by electricity, which power is also to drive the ventilation fans, from a large central generating plant of sufficient capacity to operate under battle conditions. The other electric equipment includes two large seachlights and wireless telegraphy outfit.

Two alternate proposals for powering the ships will be called for. One, which is according to plans prepared by the bureaus, is to include twin-screw reciprocating engines with necessary auxiliaries, with main engines designed to develop the maximum of about 16,000 indicated horse power on trial. Steam is to be generated by twelve water-tube boilers; besides the usual auxiliaries, there is to be an evaporating and distilling plant of 16,000 gallons capacity, a work shop, and refrigerating plant of two tons capacity. The total weight to be allowed for machinery, including spare parts, is 794 tons.

The alternate proposal will be for a vessel with the general characteristics of hull as set forth, but on the bidders' design of machinery, preference being given to a turbine installation, other things being equal.



Looking Forward at Low-Pressure Cylinder.



Looking Aft at High-Pressure Cylinder.

DOUBLE COMPOUND ENGINES FOR THE STATEN ISLAND FERRYBOATS.

Steam Turbines for the British Navy.

As a result of comparative trials of the four third-class, 3,000-ton cruisers recently completed for the British navy, very definite information is at hand concerning the efficiency of the marine turbine of the Parsons type at both cruising and full speeds. The turbine ship *Amethyst,* which underwent exhaustive trials in October and November of the past year, was built by Sir W. G. Armstrong, Whitworth & Company, Ltd., at the Elswick works, and supplied with steam turbines by the Parsons Marine Steam Turbine Company, Ltd. The other ships are the *Sapphire,* built by the Palmers Shipbuilding & Iron Company, Ltd., and the *Topaz* and *Diamond,* constructed by Laird, Cammell & Company.

The ships were designed for a speed of 21 3-4 knots, which, however, was exceeded in all cases, the maximum obtained by the reciprocating-engined vessels being 22.34 knots, while the *Amethyst* obtained a speed for four hours of 23.63 knots. By special arrangement of turbines for cruising purposes, the economy for the turbine at slow speed shows favorably in comparison with the reciprocating-engined vessels, while at the higher speeds a decreased coal consumption is in the neighborhood of 30 per cent. less than on the other vessels.

The British admiralty conducted extended trials on the *Topaz,* representing the three reciprocating-engined vessels, and on the

Amethyst. The dimensions of hull of the four vessels are identical, and will be found in Table I. The ships approach the scout cruiser class, although not of as high speed as intended for the latest vessels designed for this purpose. The armament includes four 4-inch guns with 4-inch armor hoods, and eight 3-pounders, three Maxim guns, and two torpedo tubes placed on the upper deck.

TABLE I.

	Amethyst.	Topaz and Diamond.
Length	360 ft.	360 ft.
Beam	40 "	40 "
Draft trial about	14 " 6 ins.	14 ft. 6 ins.
Displacement trial	About 3000 tons.	About 3000 tons.
Machinery	Parsons turbines 3 shafts	Twin screw 24 1-4, 38 1-2, 42 1-4, 42 1-4 24 ins.
Machinery total weight	535 tons.	537 tons.
Boilers	10 Yarrow.	10 Laird-Normand.
Grate surface	4.935 sq. ft.	.....
Heating surface	25,968 " "	26,000 sq. ft.
H. S. ÷ G. S.	52.5.	
Evaporation per sq. ft. H. S. per hour	7 07.	7.87
Propellers	3 Three bladed.	2 Four bladed.
Diam	Three 6 ft. 8 in.	
Pitch	Center 6 ft. 6.7 ins.	
"	Side 5 ft. 9 ins.	
Area each	Center 19.64 sq. ft.	
" "	Side 19.48 sq. ft.	

The unique arrangement of the turbines on the *Amethyst* permits driving them under most favorable conditions at different speeds. On the forward end of the port and starboard side shafts are placed a high- and intermediate-pressure *cruising turbine* respectively, each with drum 44 inches in diameter, but of different lengths and different arrangement of blades. Directly behind each of these turbines is, first, a low-pressure turbine 60 inches diameter, and at the rear end a backing turbine. The main high-pressure turbine with drum 60 inches diameter is placed on the center shaft. The piping is so arranged that the steam from the boiler can be led directly into either high-pressure turbine or into the intermediate turbine. Thus, at the lowest cruising speeds, steam is admitted to the high-pressure cruising turbine, thence it flows to the intermediate cruising turbine; thence to the main high-pressure turbine; finally to the two low-pressure turbines. At intermediate cruising speed the high-pressure cruising turbine is cut out, the steam entering the intermediate cruising machine, while for maximum speed both the cruising turbines are cut out, and the steam enters direct to the main high-pressure turbine on the center shaft. A forced lubrication system is fitted to the main journals.

Now, referring to the table giving the economic results of the series of trials of the two vessels, most surprising results are found, which, if they had not been semi-officially published in the *London Times* and *Engineering* might be questioned. The auxiliary machinery on the *Amethyst* exhausted direct to the condenser, and thus the low-pressure turbines did not receive the extra steam that the low-pressure cylinders of the reciprocating engines got from their auxiliaries. The effect of this on the general results will be appreciated by noting that on the *Topaz,* when running at 10 knots, 21 per cent. of the total steam was used by the auxiliaries alone, and when running at 14 knots the consumption was 13 per cent. or, 5,672 pounds of the total given in the table. Another point to be noted, is the easier steaming of the boilers on the *Amethyst.* The highest average pressure in the stoke hold for the two full-power trials was 1.65 inches; while that on the *Topaz* averaged 1.9 inches at full power. The results given in the right-hand column of Table II. are the averages of two 4-hour trials for each ship. It will be noticed here that practically 1.9 knots greater speed was obtained with the *Amethyst* on about 10 per cent. less coal. The horse powers for the turbine vessel are assumed to be the same as those of the *Topaz* for corresponding speeds, and while the total weights of machinery on the two ships are practically the same, this increase of speed, corresponding to an increase of almost 40 per cent. in estimated power, is attendant with the same weights as upon the *Topaz.* These results go to prove that the marine turbine when running at full speed is capable of an economy far in excess of other types of engines.

TABLE II.

WATER AND COAL CONSUMPTION TRIALS.

	Amethyst	Topaz	Amethyst	Topaz.	Amethyst	Topaz.	Amethyst	Topaz.	Amethyst	Topaz.
	24-hour trial at 10 knots		24-hour Trial at 14 Knots.		30-hour Trial at 18 Knots.		8-hour Trial at 20 Knots.		4-hour Trial at Full Power	
I. H. P.	897	897	2250	2251	4770	4776	7280	6689	13.500	9721
Speed, knots.	10.	10.058	14.062	14.08	18.186	18.069	20.6	20.063	23.35	21.465
Total steam per hour lbs	26,260	21,294	44,090	42,260	76,493	90,500	100,606	134,248	183,685	204,545
Steam per I. H.P. hour lbs.	29.3	23.74	19.6	18.77	16.	18.95	13.8	20.07	13.6	20.21
Total coal per hour lbs.	2893.	2296.	4725.	4640.	8372.	10,900	10,937	15,451	24,223	26,915
Coal per I. H. P. hour lbs.	3.22	2.56	2.1	2.06	1.75	2.28	1.5	2.31	1.8	2.77
Evaporation per lb. coal lbs.	9.1	9.3	9.35	9.13	9.15	8.3	9.7	8.7	7.6	7.75
Knots run per ton coal.	7.42	9.75	6.6	6.8	4.8	3.7	4.22	2.9	2.16	1.83

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, report under date of December 10, 1904, the following degree of completion of vessels building for the United States Navy:

BATTLESHIPS.			DEGREE OF COMPLETION. PER CENT. Nov. 1	Dec. 1.
Ohio	18 knots.	Union Iron Works	100	
Virginia	19 "	Newport News Co	71.21	73.43
Nebraska	19 "	Moran Brothers Co	61.4	63.64
Georgia	19 "	Bath Iron Works	67.47	69.67
New Jersey	19 "	Fore River Shipbuilding Co	70.7	72.2
Rhode Island	19 "	Fore River Shipbuilding Co	73.5	75.1
Connecticut	18 "	Navy Yard, New York, N. Y.	56.4	58.71
Louisiana	18 "	Newport News Co	61.5	64.73
Vermont	18 "	Fore River Shipbuilding Co	25.8	29.5
Kansas	18 "	New York Shipbuilding Co	31.2	35.6
Minnesota	18 "	Newport News Co	46.56	50.24
Mississippi	17 "	Wm. Cramp and Sons	11.89	15.26
Idaho	17 "	Wm. Cramp and Sons	10.61	13.4
ARMORED CRUISERS.				
Pennsylvania	22 knots.	William Cramp and Sons	94.79	97.03
West Virginia	22 "	Newport News Co.	95.5	97
California	22 "	Union Iron Works	65	66.7
Colorado	22 "	William Cramp and Sons	97.11	98.42
Maryland	22 "	Newport News Co	92.16	93.41
South Dakota	22 "	Union Iron Works	63	64.1
Tennessee	22 "	William Cramp and Sons	54.58	58.71
Washington	22 "	New York Shipbuilding Co	50.2	55.3
PROTECTED CRUISERS.				
Chattanooga	16½ kts.	Lewis Nixon	97	99.13
Galveston	16½ "	Wm. R. Trigg Co	94	95
St. Louis	22 "	Neafie and Levy Co	54	56.6
Milwaukee	22 "	Union Iron Works	60	63.2
Charleston	22 "	Newport News Co	84.34	86.06
GUNBOATS.				
Dubuque	12 knots.	Gas Engine and Power Co	68.2	72.3
Paducah	12 "	Gas Engine and Power Co	64.9	68.4
TRAINING SHIPS.				
Cumberland	Sails	Navy Yard, Boston	80	85
Intrepid.	"	Navy Yard, Mare Island	63	67.5
TRAINING BRIG.				
Boxer	Sails	Navy Yard, Portsmouth	90	95
TORPEDO BOATS.				
Stringham	30 knots.	Harlan and Hollingsworth	99	99
Goldsborough	30 "	Wolff and Zwicker	99	99
Blakely	26 "	George Lawley and Son	99	99
Nicholson	26 "	Lewis Nixon	99	99
O'Brien	26 "	Lewis Nixon	98	99½

MEXICAN GUNBOAT BRAVO, LAUNCHED NEAR GENOA, ITALY.

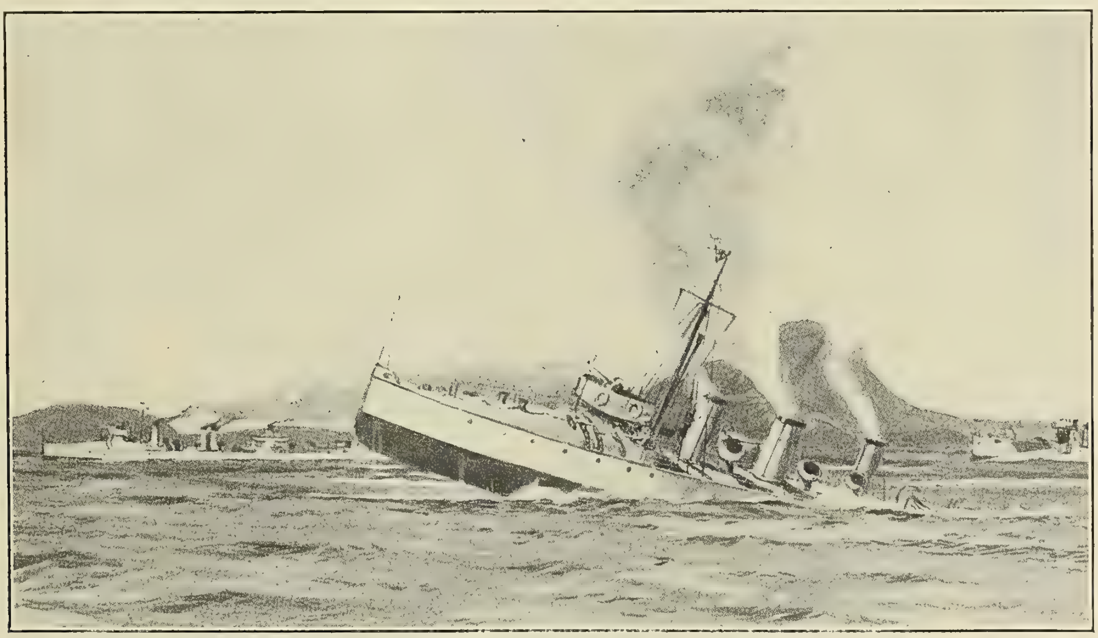
Mexican Gunboat Bravo.

There were recently delivered to the Mexican government two twin-screw gunboats, the *Bravo* and *Moreoa,* built at the Oderos ship yard at Sestri Ponente, near Genoa. The general dimensions are as follows: Length, 250 feet; beam, 34 feet; depth, 14 feet; displacement, 1,280 tons; designed speed, 17 knots. The vessels are very light draft, for navigating the shallow rivers of the Mexican coast, while at the same time the bunker capacity is sufficient to carry the vessel 5,000 miles at a speed of 10 knots. The propelling machinery consists of two sets of three-cylinder, direct-acting, triple-expansion engines of 2,600 I. H. P. Steam is supplied by two water-tube boilers.

There are two 4-inch R. F. guns of Bethlehem make, which fire directly ahead and astern respectively, and have a total arc of fire of 150 degrees; four 2 1-4-inch R. F. G., Schacidercant type, are fitted on broadside and one on the bridge. The 4-inch guns are supplied with ammunition by electrical hoists capable of delivering 24 charges per minute. Electrical hoists are provided for the other guns also. The crew will be composed of 26 officers and 90 men, and in addition quarters are provided on board for about 270 troops. There are six boats, two of which are steam launches, for quickly disembarking the troops. Fresh air is supplied to the quarters by electric fans, and a large refrigerating plant is installed. The *Bravo* will proceed direct to Mexico as soon as she has completed her trial trip.

British Destroyer Chamois Sinks.

While running at full speed, in company with nine other destroyers, off the coast of Greece, the *Chamois* met with a mishap to her machinery and sank in deep water. All of the crew escaped, but the exact cause of the accident could only be surmised. It is believed that the port propeller brackets gave way, carrying the shaft and propeller with them. The port engine immediately raced and wrecked itself before steam could be shut off. The after end of the hull was badly damaged, probably by the twisted shaft, or the propeller striking the thin hull plates, and the after compartments were immediately flooded. The vessel settled by the stern, and, as the thwartship bulkheads gave way under the water pressure, the machinery space was flooded, and the vessel sank stern first, as shown in the illustration, which is reproduced from London *Illustrated News.*



BRITISH DESTROYER CHAMOIS FOUNDERING IN THE MEDITERRANEAN AS A RESULT OF MACHINERY ACCIDENT.

Marine Engineering

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IN taking a retrospect of shipbuilding for the year just closed, the only encouraging feature seems to be that it is apparently impossible for shipbuilding to go through a more depressed season than that of 1904. Three of the large over-sea freight carriers that have been under course of construction for a long time were finished, and there remains but one deep-sea steamer building at any American shipyard. The worst feature is that there are few new orders and but very little prospective work in sight. The policy of retrenchment observed by the shipyards for the last three years has about reached the limit, and it is to be feared that the depressing conditions may force the few remaining solvent companies into bankruptcy. The year has recorded the re-organization of the shipbuilding trust into the Bethlehem Steel Corporation; some of the smaller yards have applied for receivers, while a few others, which had been forced to close, have been able to re-open their gates. If it were not for the government work in hand, every one of the large shipyards would be closed to-day.

In passing from this doleful retrospect to the outlook of the present year, we regret that we cannot picture it in rosier colors. Recent bids opened for one battleship and two armored cruisers disclosed figures far below (about 10 per cent.) the estimates on the same work of last year, and are an index, first, of the needs of the shipbuilder for more contracts, and, second, that the economies of construction have been carefully observed at every point. The closing days of the year recorded the placing of orders for two coasters and a night bay steamer. The orders for ferryboats for several railroad companies with terminals at the port of New York have furnished the backbone of merchant contracts for the year. This class of boat has passed through a complete evolution within the last few years, and the double-end, double-screw, steel ferryboat is now accepted as standard.

Fortunately, the Naval Board of Construction has decided to adhere to its policy of recommending the building of two battleships and one armored cruiser, besides necessary attendant craft, each year. Thus it is proposed that three battleships be ordered by the coming congress, to make up the average fof the two years. Besides this, it is understood that five scout cruisers and several torpedo vessels are to be included in the bill. The scout cruisers are of the same general type as those now under consideration by the department, general features of which will be found elsewhere. The building of the Panama canal will necessitate vessels and barges of every class, from steamers suitable for the New York-Colon service to dredges and barges engaged in the actual construction work. Already plans are being prepared for the large steamers, and the amount of traffic, both freight and passenger, to and from the isthmus, is even now increasing at a very rapid rate. The extension of the coastwise laws to the Philippines will assuredly stimulate the growing trade with that archipelago, and especially the shipbuilding industry of the Pacific.

Be these influences as they may, the general trade conditions of the country are infinitely better than they were a year ago, and there must shortly be a demand for ships in the natural development of our inland and coastwise commerce. For any definite improvement in the foreign trade we must, however, await the decision of congress. At the time of writing, the bill prepared by the combined congressional commission to propose a plan for aiding the American merchant marine, is about to be presented, but comment must be deferred till the next issue. It is evident that the commission has worked with a view of drafting a law for the encouragement of the American ship that would not entail a direct charge upon the treasury. Just what action congress will take on this measure it is folly to predict.

The one bright spot in the year's work is the activity of the ship yards on the great lakes in preparing for the coming season. Many orders for new ships have been placed, and, while the number of ships and tonnage does not equal that of two years ago, the record year, it is most satisfactory, and includes several vessels of the largest displacement of any fresh-water ships afloat. The great lakes yards offer an illustration of how the cost of shipbuilding may be reduced when the demand is sufficient to warrant specializing the types of vessels.

TURNING now to the progress made in naval architecture and marine engineering, the stagnant condition of the industry naturally has prevented any marked developments. In good times, when the shipbuilder proposes a radical change, the prospective owner will give it more consideration than in the dull season, when the trade does not warrant investigating new types. Another record has been made for the largest ship in the world by the addition of the steamer *Baltic* to the transatlantic fleet, exceeding by 26 feet in length and about 3,000 tons, the registered dimension of any previously existing ship. The increased earning capacity of these huge moderate speed vessels has been very marked, and the year has recorded several orders for this type built in Great Britain, practically all for the North Atlantic lines, and one measuring over 700 feet is now under construction in Germany.

The development of the cargo steamer has received a great deal of attention, especially the means of loading and discharging bulk cargoes. The low figure at which thousands of tons of freight is carried has necessitated many radical changes in the plans and equipment of the ship. On this side of the Atlantic the latest successful production has been the *Augustus B. Wolvin* of the great lakes, which represents the most approved design for discharging by machinery practically the entire cargo. An unobstructed hopper, extending from the machinery space forward, a distance of some 400 feet, is built with slanting sides inside the ship. The unloading machinery, erected upon the pier, has free play through the large hatches, spaced 12 feet centers, and for supporting the deck a special arched girder is substituted for the usual deck beam. The success of this arrangement is so complete that many new vessels of the same design are now under construction. On the other hand there has been perfected a type of carrier which is entirely independent of apparatus on shore for discharging the cargo. Twin masts or derricks are spaced between hatches at frequent intervals, and are so rigged with booms, buckets and winches that they can unload in a very short time. Another type of vessel which has met with great favor and for which many orders were placed last year is the suction dredge. The principle on which it acts was practically undemonstrated ten years ago, and by its adoption the capacity of discharge per horse power has been increased almost tenfold over the bucket type. The national work of deepening our harbors and navigable rivers has now assumed such large proportions, and the equipment demanded by the construction of the Isthmian and New York state canals, will call for many more of these vessels. Mention should also be made of the turret steamer, which has met with as much favor on the other side as the whaleback type has with disfavor in this country.

During the year, probably the greater attention has been given to ship propulsion than to any other phase of marine engineering. The year has marked the check in the tendency of increasing steam pressures. From the time of the old beam engine, of forty years ago, using 30 pounds per square inch, there has until the present been a steady rise in pressure, corresponding to the increase in strength of materials and engineering progress. The naturally increased weight attending higher pressures, the difficulty of keeping steam-tight joints and other reasons, have caused the engineer to look elsewhere in the cycle for further increase of efficiency, and the steam turbine has, it is interesting to note, shown him that this increase may be obtained at the lower end of the expansion, as well as by the use of superheat. The progress made with the steam turbine has been a natural one along the lines indicated by former installations. Increased vacuum is now obtained by means of dry air pump, or the augmenter condenser, while the resulting lower temperature of the hot well is compensated for by the multiple feed water heater.

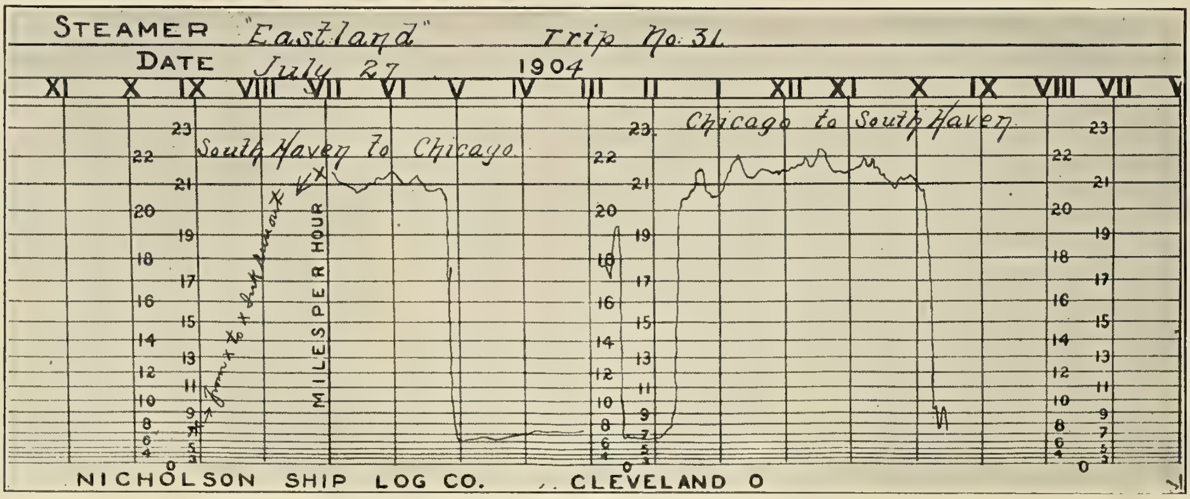
By far the greatest interest is directed to the two 23-knot express steamships building for the Cunard line, and which are to be powered with steam turbines. The coming year will doubtless witness the trials of several Atlantic steamers, now nearing completion, with this type of propelling machinery, and these results must be the real index as to the commercial efficiency of the Parsons steam turbine for vessels of average speeds. We have from time to time given account in these columns of the progress of this class of work, and it is well known that the advisory board, which has the design of the Cunarders in hand, and which is composed of the most eminent British engineers, has been conducting exhaustive experiments on model hulls and propellers. The results of the four new Irish channel vessels, all of the same dimensions, two of which are fitted with turbines, appear to indicate from the preliminary figures given out that the turbine is most successful.

The recommendation of the Admiralty Boiler Committee to henceforth adopt the water tube boiler in all British warships, has done much towards clearing up the controversy and defining the efficiency limits of the two classes. However, the old Scotch boiler with all its foes will be seen for many years to come in most classes of merchant ship. In this respect it is interesting to note that the Cunard vessels are to be fitted with this class of boilers. Assisted draft, thereby increasing the evaporation per square foot, has prevented the abandoning of the Scotch where large power is required.

All things considered, the past year may be looked upon as an important one in partially demonstrating the theories advanced during the last few years, and we may look upon the present year as one for further demonstrating whether or not our investigations have been molded along correct lines.

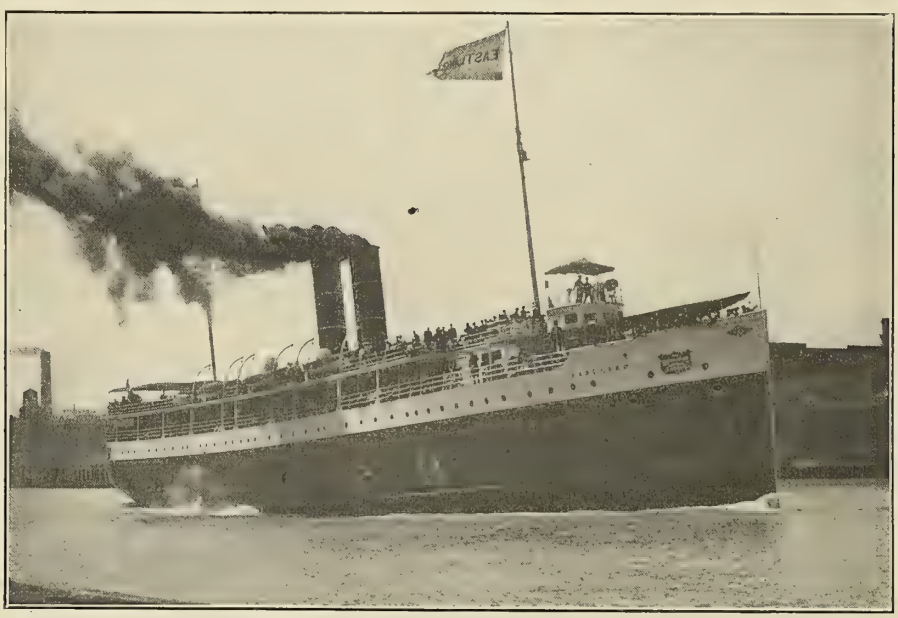
High Speed of the Eastland.

The steamer *Eastland*, built by the Jenks Shipbuilding Company, in 1903, for the Michigan Steamship Company, has proven to be a very fast and successful boat. The speed attained is strikingly illustrated by the record here reproduced from the



CONTINUOUS LOG TAKEN ON THE FAST RUN OF THE EASTLAND.

Nicholson ship log, which is fitted on the steamer. On July 27 the run from Chicago to South Haven, a distance of 79.5 miles, was made in 3 hours 44 minutes, and the average speed for 3 1-2 hours of the run was about 21 1-2 miles. The variations in speed at starting and during the trip, due to the wind and variations of engine revolutions, are clearly indicated on the card.



FAST PASSENGER STEAMER EASTLAND, IN SERVICE ON LAKE MICHIGAN.

The *Eastland* is 275 feet long, 38 feet beam, and 22 feet 8 inches deep, molded. There are two sets of triple-expansion engines, the diameters of the cylinders being 21, 34, and 56 inches respectively by 30 inches stroke. Steam is furnished by four Scotch boilers, 13 feet 6 inches diameter by 12 feet long.

Serious Collision of the Martello.

The steamship *Martello* was prevented from foundering in a head-on collision with the *Holywell*, on the east coast of England, by the fact that the second bulkhead was well forward. As shown in the engraving taken of the ship in dry dock, the forward collision bulkhead was entirely destroyed, and if it had not been that a second bulkhead was well forward it is probable that the ship would have foundered. The collision took place at 2 o'clock in the morning of February 21, 1903, while the *Holywell*, hailing from Sunderland, was on a voyage from Middlesbrough via London for the east coast of Africa. The *Martello* sailed from New York to Hull. The *Martello* struck the *Holywell* on the starboard side amidship, and sank her in fifty minutes.

Before the vessel was built, when the plans were presented to the owner, he passed the remark that if the vessel at any time should have a big collision the second bulkhead would be of little use, so the bulkhead was accordingly built 40 feet forward. It is a remarkable thing that after nineteen years she should be saved in reality as a result of his argument.

Only one life was lost through the collision—that of a fireman who lay asleep in his bunk. The *Martello* was eventually repaired at Hull and is now trading between the United States and Hull. She is 370 feet long, 43 feet 1 inch beam, and 28 feet 4 inches deep. The propelling machinery consists of one set of triple-expansion engines, 26 1-2, 50, and 82 inches by 57 inches stroke. She was built by the Earles Shipbuilding and Engineering Company, Ltd., of Hull, England, in 1884, and in 1900 was fitted with new Babcock and Wilcox water-tube boilers. The vessel belongs to Thomas Wilson, Sons & Company, Ltd., Hull, England.

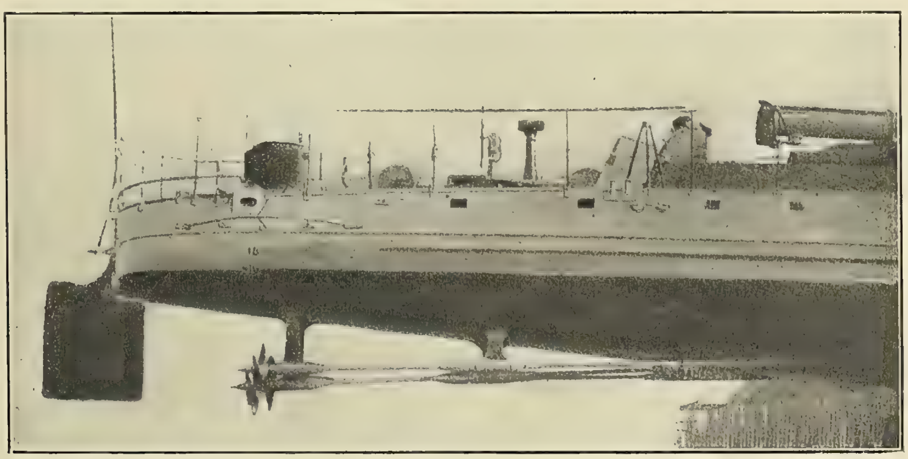
French Turbine-Propelled Torpedo Boat.

The first vessel of the French navy to be fitted with Parsons steam turbines has recently completed her trials, and is described in London *Engineering*, from which the accompanying facts and photograph are taken. The boat is numbered 293, and is 130 feet long, 114 feet beam and 94.6 tons displacement, with 19.5 tons load—in fact, is as near like the reciprocating engine-propelled

THE DAMAGED MARTELLO DISCHARGING HER CARGO.

THE MARTELLO IN DRY-DOCK, SHOWING DAMAGED COLLISION BULKHEAD.

torpedo boats of the same type as was possible to build, modified only to suit the turbine machinery. Two Normand water-tube boilers supply steam at 250 pounds pressure. The hull was built by Augustus Normand & Company, and the engines by Parsons



FRENCH TORPEDO BOAT 293, THE FIRST TO BE FITTED WITH PARSONS TURBINES.

Marine Steam Turbine Company. A high-pressure turbine is fitted on the port wing shaft, and exhausts into the intermediate-pressure, driving the starboard wing shaft, which in turn exhausts into the low-pressure turbine on the center shaft. This arrangement is only for speed above 17 knots; for all lower speeds an additional high-pressure turbine is employed, and the ordinary high-pressure which receives its exhaust becomes the first intermediate. This cruising turbine, as it is called, is placed on the center shaft and coupled to the low-pressure turbine, and, when not required, steam is simply shut off from it and it revolves idly in a vacuum. The auxiliaries include two Normand condensers, Weir main and auxiliary feed pumps, air pumps driven by a reduction gearing from center turbine shaft, Norman feed heater and filter, etc. Reversing is accomplished by a set of reversing blades fitted at the aft end of the low-pressure turbine.

The eight-hour official consumption trial at 14 knots resulted in boilers taking 683 pounds of coal per hour, and the two hours' continuous fuel speed runs gave an average of 26.205 knots and 26.663 maximum. An analysis of the trials compares favorably with reciprocating-engined torpedo boats, for with the cruising turbine low coal consumption was attained such as not heretofore attained with turbines. In some torpedo boats the reciprocating engine has been fitted for cruising speeds with turbines for full power, which double arrangement is not altogether to be recommended.

An Engineer's Yarn.

BY WILLIAM J. AUTEN.

We were well by Hatteras on the trip north, bound for New York, when I came on watch at 12 o'clock one evening last February. Although we only made about 10 knots, loaded as deep as we were, still, even by moderate reckoning, we should make the Highlands by at least 4 bells the next afternoon, which in turn ought to leave us tied up at the dock that same night.

Possibly you who do not "go down to the sea in ships" cannot realize how much a lone coaster longs for a night ashore, especially when his packet hails from Boston, with but an occasional call at the Imperial city, and, too, when his hope of future happiness is enthroned in one of Gotham's "double-deckers"; despite his glowing descriptions of his native city of such social standing that one of its tea parties has been handed down through history.

We carried the usual complement of a 2,000-ton freight steamer —a fair-sized triple, two Scotch boilers, with Howden draft and a *leaky* condenser, over all of which your humble was the usual grumbling, second-assistant engineer.

Now, to be called out at midnight to go on watch, doesn't improve a fellow's temper, anyway, and when I found we were only doing about 47 "turns," carrying 132 steam and fans shut down, I naturally felt grumpier than usual, for the picture of those glimmering lights at the pierhead were growing fainter and fainter. A glance at the log slate confirmed the worst—the turns had dropped from the first watch at 88.2 to 58.6 in the watch of our glorious third; the steam from 184 (she popped at 185) to where the pointer bobbed now, and the wind from 3 1-2 inches to 0. The remarks column settled it. No Pier 2 to-morrow. It ran:

"9:02 P.M. Blowed starboard boiler down; 2-inch surface below.

"9:46. Ditto for port boiler.

"10:02. Shut down blowers.

"10:12. Slowed engine to 50 turns.

"11:04 and 11:50. More blows.

"Condenser leaking badly, boilers priming, and drains wide open."

I closed the slate and stumbled out into the fire room. Plenty of water—over two gauges in each boiler. A predominance of salt sickles around trifling leaks bore mute evidence to the fact that the condenser was leaking. I relieved the "third." He didn't need any second invitation, either.

After promenading the lower grating awhile, dodging the showers from the high-pressure rod as she "took it over" (that metallic packing never would hold water, anyhow), I thought I'd make a last feeble attempt to drive her through the water a little faster, and tapped the throttle down a bit, but she wouldn't stand it; a couple of reports from the cylinder artillery were very convincing.

And then? Well, I lapsed into one of those day dreams that last the whole watch, including its usual duties, but which is made up of a certain pretty shore vision. But, strange as it may seem, an idea disturbed the vision that night; and it grew, too, as the fancy receded, and finally enthroned itself in burning letters, as my little fairy vanished with a longing adieu. Those letters sputtered and burned, and finally spelled themselves into "Superheated Steam."

My promenade down the grating came to a sudden pause, and a few seconds later I started off with a definite idea in view. The feed pump was the objective point. This I slowed down and watched the valuable feed water run into the bilge; but it was pretty brackish, anyhow, so I didn't care. The water came down in the boilers all right, but I kept just an inch or so in sight before I let the pump go again. Dangerous? Well, perhaps, but I had my eye on it, and we were bound for New York now.

It is part of the usual routine to wake dago firemen out of a trance, but they came out of theirs quicker than usual that night. The fans were going, too, before the pointer had gained more than a pound or two.

Then I went for the main stop, my trump card, shut it down full, and then opened it about a turn or so. The throttle got a dose of the same medicine next. I stood by, then, and watched results for a minute. She was doing 52 with less grumbling than her 45 a half-hour ago.

As the steam came up I opened the pass-overs. That did the business, I tell you. Even the oiler had to wake up, for my new supply of "hot air" was talking French to the speed counter—an agreeable language just about that time. I had to open the stop a bit more, for the boiler room gauge was creeping up too fast; however, she behaved like a lady, and only had one or two attacks of the sniffles—none very serious. I got the drains shut up, too, except the low, which I left open a bit to keep on the safe side.

The howl for steam became quite genuine; reminded me of the days of government trial trips, when the speed bonus was in vogue, with just two differences: one the size of the plant concerned, the second the size of the bonus, the former being as small as the latter was large. Whenever we made a pound or two of steam I would open the pass-overs a trifle more, then dive for the fire room, to help my dagoes do stunts with their slice bars before she dropped back again.

This was the state of things when the "first" showed up at 8 bells, but he only smiled when I told him what I had been up to. (He was a New Yorker himself, by the way). There was a rather serious look on his face, however, when I wrote four inches under "Air pressure in ash pits" on the log slate. We figured up the turns together and got 72.4 for the average. Then, after a talk about the water, which hugged the bottom of the glass pretty closely, he decided it was all right, and I departed for the land above decks, where the air is free and pure and you don't have to know the difference between a safety valve and a cylinder head.

That was a straggly looking trio that passed my state room on their way to the forecastle, and for once in their lives I believe those firemen earned all that the company paid them.

My system lasted all the way in. We crossed the bar at about 6 bells that afternoon, and were tied up shortly after dark. Then I made my vision a real fact.

Valve Diagram with Meyer Cut-Off.

In the October number of MARINE ENGINEERING an instance was given of how the indicator may be used to take a diagram of the motion of a valve, where the travel does not exceed the length of the drum. This method of analyzing a valve motion deserves to be better known, as it proves highly instructive to the engineer who applies it to his own engine.

Here is reproduced a section of the valves and a pair of diagrams taken on board the steamer *G. W. C——*, from a Meyer cut-off gear of 4 inches travel of main and cut-off valves. A drum made from a piece of 5-inch brass tubing, and run from the regular reducing motion gave a card 11 inches long. The large ellipse gives the motion of the main valve, as was explained in the former article. The narrow diagonal diagram represents the cut-off valve. Theoretically, this should be a straight diagonal line, since the center of the eccentric is opposite to the crank center. But the regularity of the connecting rod causes it to sag in the middle of the stroke; and the stretch in the cord is responsible for the double line instead of a single one.

To show on the diagram the different adjustments of the valve, this line must be reproduced in different heights, corresponding to the amounts the two valve plates are moved apart. Steam is cut-off by these plates at the outer edge of the steam ports *through* the main valve. The inner edge of the same port controls the opening to the valve seat port, and is represented on the diagram by the periphery of the ellipse. Accordingly, the part through the main valve will be located along the side in the ellipse and will show the opening in reference to the cut-off valve, as the steam port in seat shows the opening given by the main valve.

With this arrangement it will be noticed that the steam opening overlaps slightly into the exhaust opening *in the diagram*, but this need cause no confusion.

On the diagrams here given can be seen the earliest and latest points of cut-off possible in this particular case, while the steam opening used under ordinary running conditions has been shaded, for easier comparison with the cylinder cards taken under the same conditions. This grade of expansion is a little beyond the raising or lowering center line and other lines half the amount of the difference. Travel is changed by regulating vertical height of ellipse; the laps, by drawing new lines. Advancing eccentric on shaft tends to make the ellipse narrower, until it would approach a diagonal line, as we have seen in the case of the cut-off eccentric, whose center is opposite to that of the crank.

It is interesting, also, to note that the effect of linking up the main valve (shortening its stroke) is to give a later cut-off.

O. O.

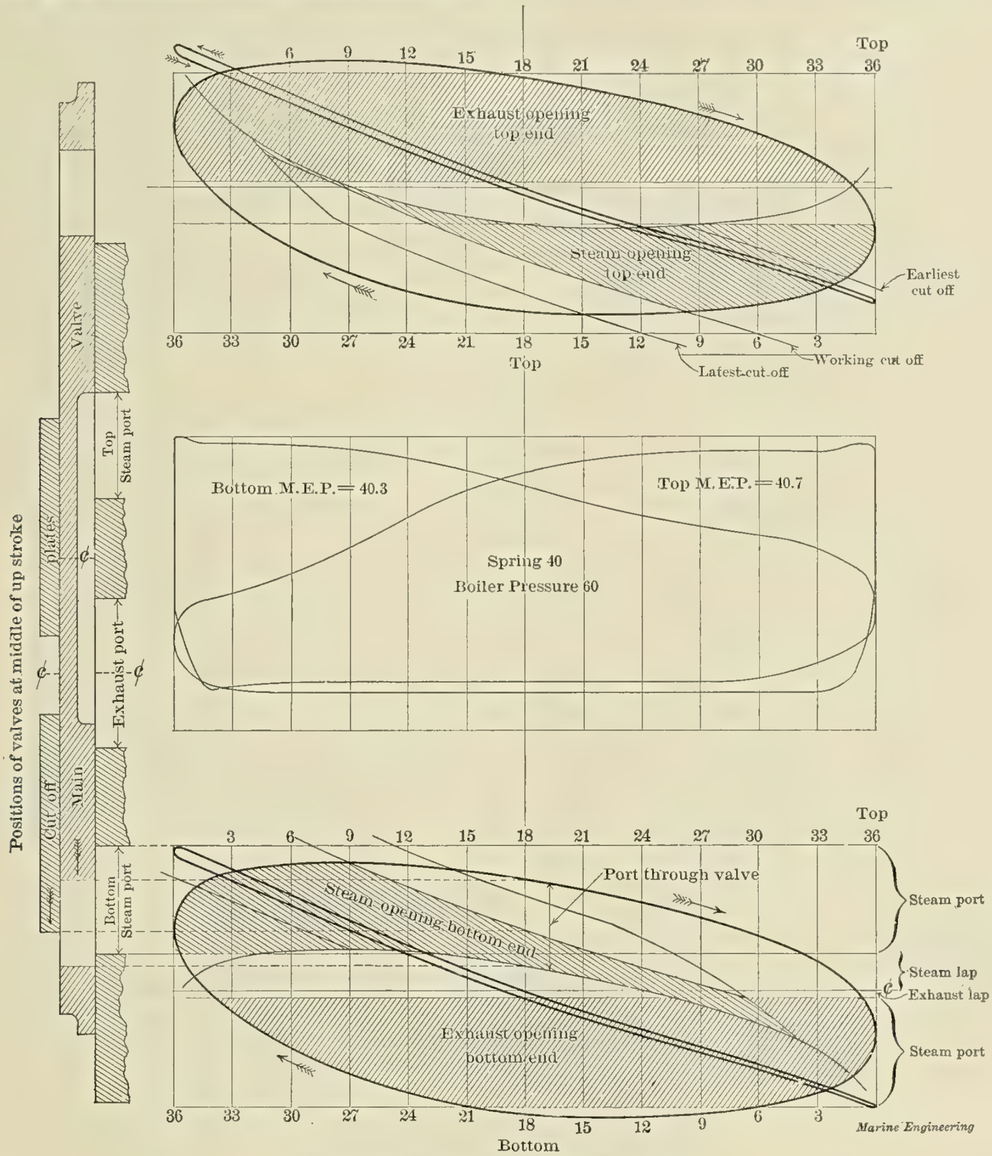


DIAGRAM OF VALVE WITH MEYER CUT-OFF GEAR.

range of the extra cut-off, so that the steam is following until the main valve shuts the port at 32 inches. The common trouble with a plain slide-valve engine of getting the heaviest M. E. P. on the down stroke has been overcome in this case by raising the cut-off valve (lengthening the rod). The result is an interesting difference of appearance of the top and bottom cards.

One should expect a more rapid cut-off where an independent valve is provided. It is revealed here, however, that it is pretty slow at any point, and especially after passing the middle of the stroke, when the motions of the two valves nearly coincide. Giving the cut-off valve longer travel would improve the gear in this respect.

In cases where changes in the valve gear are proposed, such diagrams as these would be useful in studying the effects the changes would have on the steam distribution. Thus, for instance, difference between top and bottom lead is allowed for by

ENGINEERING SPECIALTIES.

New Vertical High-Speed Engine.

The illustrations presented herewith show a small vertical engine, recently placed upon the market, which possesses unique features of great merit. From Fig. 1 it will be seen that the engine has easy curves and graceful lines, giving it a handsome appearance. It is fully enclosed, preventing the foreign matter getting into the working parts or the oil from leaking out, yet the parts are easily accessible upon the removal of the enclosing plates by simply turning a milled hand nut and lifting out.

The most striking feature of the engine is its oiling system. Up to the present time most of the small engines upon the market have depended almost entirely on the splash system for lubrication, which is seldom thoroughly effective, and for vertical double reciprocating engines is positively unreliable. The system embodied in this engine is claimed to be different from any of the usual methods, and has proven very successful. Every frictional surface is running on oil, with the effect of almost eliminating wear. Positive circulation of the oil is secured by means of an oil pump *A*, driven from the main shaft by the eccentric, *K*, shown in Fig. 2. The oil is forced up through the tube, *B*, into the small strainer, *C*, from whence it drops into an oil box through the bottom of which four tubes project. In one side of each of these tubes there is a slot, so that when the oil box contains only a small amount of oil, each tube can take only its proper proportion. In case the box is full, all the tubes get more oil in proportion to the increased height.

Two of these tubes, *F* and *C*, and two on the opposite side not lettered, apply oil to the guides, the oil dropping into a small oil trough through, *G*, from which it runs into the bearing through a small oil hole. The crosshead pin is supplied by the tube marked *E;* the oil drops into the cup, *H*, and fills the cavity between the bolt and inside of crosshead pin and the oil grooves. The oil dropping from the crosshead is caught in two pans attached to the inside of the covers. From these oil pans it runs down the inside of the cover dropping into a cup in the top of the main bearing cap. Instead of oil grooves at the top and bottom of the main bearing, as ordinarily made, in this system the oil is supplied at the sides where the bearing is cut away at the joint. When the strain from the connecting rod is up the oil is carried to the bottom of the bearing, but when the load is reversed there are no oil grooves to carry away this oil. The crank pin is oiled through the tube marked *D*, which discharges into a crank oil ring inside the eccentric, which in turn discharges into the crank-pin oil tube, and flows across the crank-pin bearing. The crank-pin oil ring in addition to its independent supply catches the drip from one end of the main bearing. The eccentric is well oiled by the drip which it catches from the other end. A portion of the oil as it drops back into the bottom of the frame drops upon an oil filter where it is thoroughly cleaned and purified. The large base gives the oil an excellent opportunity to cool and settle.

In their own shops, where the manufacturers have been experimenting with this engine for some two years past, it is stated that an engine adjusted and filled with oil on March 10, had no adjustments made of any character up to July 15, and no oil added except to fill the sight feed lubricator. It has since been operating from fourteen to sixteen hours per day driving a blower, and after a lapse of over four months really needed no adjustments or fresh lubricant, running almost as noiselessly as at first. It will thus be seen that this engine is particularly valuable for applications where continuous operation is required or peculiarly heavy duty imposed upon the engine, as in driving blowers, dynamos, pumps, etc.

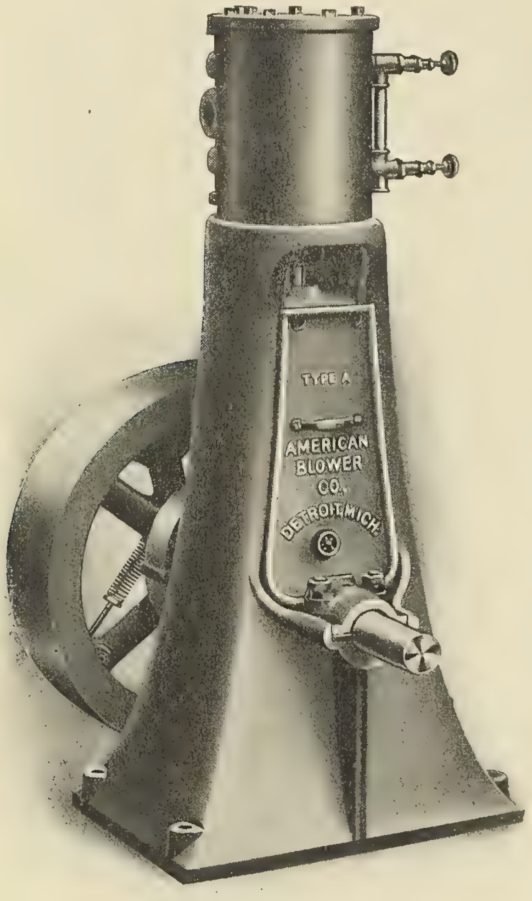


FIG. 1.—NEW VERTICAL HIGH-SPEED ENGINE.

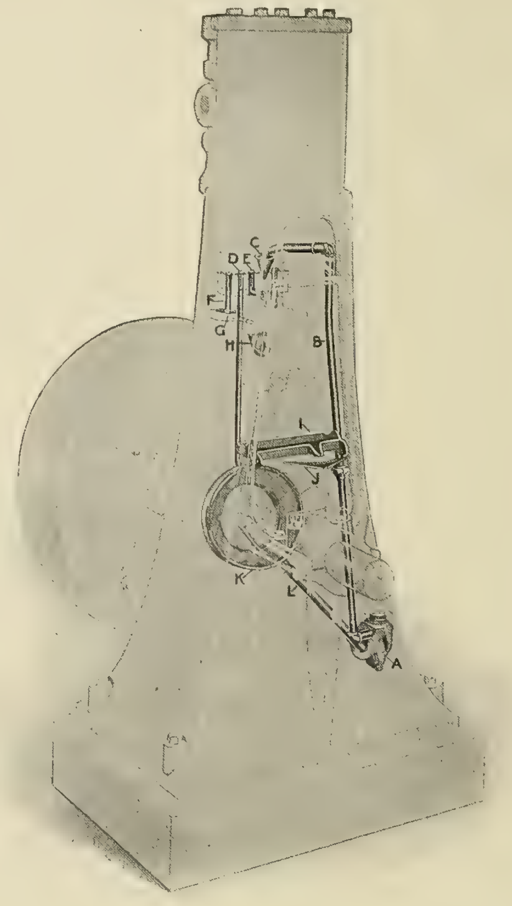
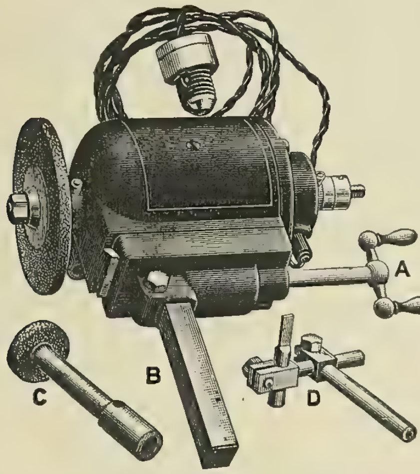


FIG. 2.—POSITIVE LUBRICATING SYSTEM.

Further information can be obtained from the designers and builders, American Blower Company, Detroit.

Portable Electrical-Driven Grinder.

An electrical-driven grinder, recently placed on the market and here illustrated, has a wide range of work, such as grinding centers, cutters, reamers, dies, and for surface, parallel, and internal grinding jobs of all kinds. The machine is portable, the largest size, of 1 horse power, weighing but 65 pounds; and the smaller size, of 1-4 horse power, weighing only 16 pounds. The grinder is set in the tool post of a lathe, planer, or milling machine, or may be clamped in a vise. The equipment includes all the parts shown in the cut, and the machine is started running by simply attaching the plug to an incandescent lamp socket and turning on the current. The standard motors for driving the grinders are wound for either 110 or 220 volts, direct current unless otherwise specified. All the parts pertaining to the motor are incased in a dust-proof shell.



PORTABLE ELECTRIC-DRIVEN GRINDER.

The spindle carries taper cone bushings, running in 3-degree and 45-degree bearings. They are adjustable to wear, by means of a nut on the rear end of spindle, and are provided with dust-proof caps. The V slide has a 3-inch travel, by means of a worm through handle *A*, and is fitted with gib to take up the wear.

The shank, *B*, is of steel, and is fitted to hole in V cap. It is held in position with a screw, so that different size shanks can be used. The extension mandrel, *C*, is used for internal grinding by removing the regular wheel and attaching mandrel in its place.

The tooth rest, *D*, is a valuable attachment, serving as an index for cutter and reamer grinding.

As readily seen this combination grinder is a time-saver, but simple in its adjustment and easy to operate. This grinder is manufactured by the Hisey-Wolf Machine Company, Cincinnati, Ohio.

The Sensible Screw Driver.

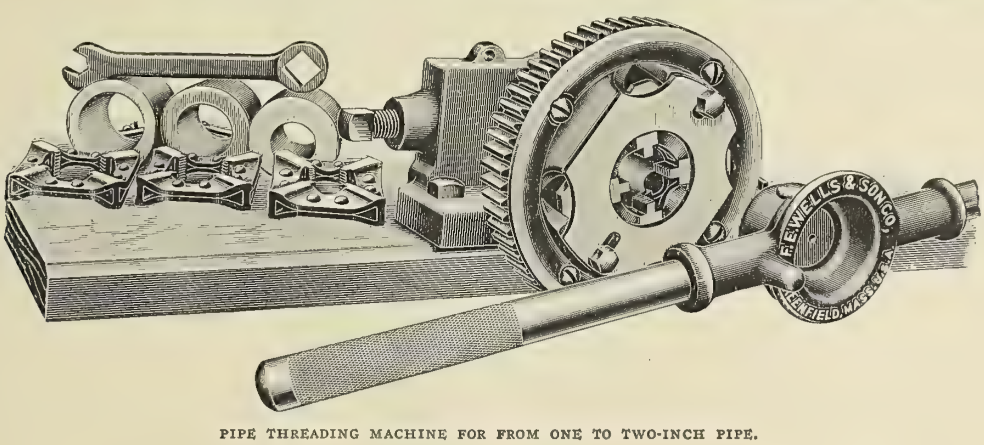
The *Sensible* screw driver, made by the Vanderbeek Tool Works, Hartford, Conn., is built on an entirely new principle. It is admitted that the only working point of a screw driver is the extreme end; therefore, if an inserted blade is used, it may be made of the best steel manufactured at a minimum cost. It may also be hardened and brought to a positive spring temper which will be guaranteed against breaking or twisting. In this *Sensible* screw driver the blades slide in the slot and are held by friction that will not get out of order. Each blade is double-ended, thus giving two sizes of drivers to each blade. The extra blades are carried in the recess in the handle, and here again is a unique feature of this screw driver. The cap to the recess is of tempered steel and forms a substantial head for hammering on. Of course a screw driver is not intended to be used as a chisel, but at some time every one does make this use of it. The *Sensible* screw driver can stand this treatment without damage. It is made in five sizes and each size is supplied with a strong steel snap for holding the screws, as shown in the illustration.

SCREW DRIVER WITH REMOVABLE BLADES.

New Pipe-Threading Machine.

F. R. Wells & Son Company, 37 Biddell street, Greenfield, Mass., is putting on the market a new pipe-threading machine, as shown herewith, for threading 1 to 2-inch pipe. It is a very simple, compact little machine weighing about 45 pounds, that is used much like a hand die stock, only having gears to multiply the power so that one man can alone easily thread pipe that usually takes two with a hand stock.

The die is held in the large gear, which has a threaded shank that screws into the main frame and acts as a lead screw to start dies. The pipe is centered by means of bushings the same as in an ordinary die stock, and is held from turning by two vise jaws on the back of machine operated by set screws. The gears are all machine cut and all castings are of malleable iron to save weight and give ample strength even for the hardest usage. The die can be bolted to either a bench or post and the vise, which is a part of the machine, can be used in place of an ordinary pipe vise. The *Economy* dies, made by the same company, are furnished with the machine, but any standard solid square pipe die will fit.



PIPE THREADING MACHINE FOR FROM ONE TO TWO-INCH PIPE.

The moderate weight and small amount of work permits the machine being sold at a low price.

ABSTRACTS FROM RULES AND REGULATIONS OF LLOYD'S REGISTER OF SHIPPING.

EDITION OF 1903.

ARRANGED BY HARRISON S. TAFT.

Among the large number of hand books published upon engineering subjects, there does not appear to be one devoted especially to the subject of shipbuilding, covering that part of the work which distinctly comes within the supervision of the hull department. Most of the hand books now in existence generally deal with the engine side of the shipbuilding industry, devoting but a few pages or so to the questions of vital interest to the hull department, and these few dealing more on theoretical matters than on the practical details of steel construction as applied to shipbuilding.

In the rules and regulations of the various shipbuilding societies, as *Lloyd's Register*, the *American Bureau of Shipping*, etc., we find the details of practical shipbuilding fully and laboriously treated, but somewhat involved and beyond the limits of an ever-ready hand book. Consequently, it is believed that there is room among the archives of shipbuilding literature for a series of articles treating entirely on the practical side of the subject in such a way as to be equally within the comprehension of the American ship fitter, as well as that of the executive heads of our shipyards.

In the following articles the endeavor has been made to give a thorough and accurate abstract of the rules and regulations of the principal shipbuilding societies, of the Bureau of Steam Navigation, and of certain information published by our Navy department. The subject matter is set forth in tabulated form wherever possible. It is assumed that the reader has some knowledge of the original set of rules and regulations from which the abstracts have been made, so as to readily understand the terms and expressions used.

1. *Measurements.*

TABLE I.—MEASUREMENTS FOR SCANTLING NUMBERS.

ITEM.		One-Two-Three-Deck Vessels.	Spar Deck Vessels.	Awning Deck Vessels.
Length.—From aft part of stem to fore part of stern post	L	On upper deck.	On upper deck.	On main deck.
Depth and girth	D-G	To " "	To main "	To " "
Breadth	B	Maximum beam.	Maximum beam.	Maximum beam.
First Number.—Frames, reverse bars, floors, bulkheads	F	a. $\frac{1}{2}B + D + \frac{1}{2}G$	$\frac{1}{2}B + D + \frac{1}{2}G$	$\frac{1}{2}B + D + \frac{1}{2}G$
Second Number.—Keel, stem, and steel frame, keelson and stringes bars, keelson stringers, shell, and deck plates	S	$F \times L$	$F \times L$	$F \times L$
Equipment Number.—Anchors, chains, warps	E	S	b. $F \times L$	Complete, $S + \frac{1}{8}S$ Partial, $S + \frac{1}{L}\frac{1}{8}S$

a. Three-decker only. $\frac{1}{2}G$ = girth of $\frac{1}{2}$ midship section. Depth to include round up of beam.
b. Depth and girth measured to upper deck.
c. Partial awning decked, poop, top gallant fo'castle, bridge house or a raised quarter-deck vessel to have their equipment nnmber equal to that for a flush or spar-deck vessel increased by that proportion of the addition made for a complete awning deck, which the combined length of the erections bear to the length of the vessel.

Sailing vessels with a poop, top-gallant fo'castle, or raised quarter-deck to have their equipment number measured by $\frac{1}{16}$ beyond that which it would be if of flush-deck type.

In spar-deck vessels two depths may be taken off actual depth to main deck in determining stringer plates, steel deck, and tie plates.

2. Stems, Stern Frames, Bar Keels.

The lengths of scarphs should be at least 9 times thickness of keel.

3. Stems.

STEMS are to equal scantling of a bar keel and to maintain their full section to load W. L. with a reduction to 3-4 said section at head.

4. Stern Frames.

1. The aft end of the scarph with keel should be at least 1 1-2 frame spaces forward of the stern post in sailing vessels and paddle-wheel steamers, and 2 1-2 frame spaces forward of propeller post in screw vessels.

2. With screw vessels whose second number is 20,000 and over, the propeller post is to be extended so as to be connected to a deck beam with a deep transom plate.

3. When stern frame is made in more than one piece, length of scarphs to be not less than three times, and width not less than 1 1-2 times the width of stern post, secured by at least four rows of rivets.

4. Rudder posts of sailing vessels and of paddle wheel steamers may be reduced from full section at bottom of transom frame to 3-4 said section at head of post. In single screw steamers the reduction to be according to rule.

5. GUDGEONS to be spaced from 4 to 5 1-2 feet apart. In depth to be not less than 7-10 of the diameter of rudder head and in thickness 1-2 diameter of pintles.

5. Keels and Center Line Keelsons.

1. CENTER THROUGH PLATE KEEL AND KEELSON.

a. These shall extend from lower edge of keel to top of floors, with side plates of same depth as a bar keel. The combined thickness of center and side plates shall equal that of a bar keel. There shall be horizontal plate stringer, at least 3-4 breadth of garboards in width, on top of floors at middle line of ship, and connected to top of vertical keelson plate with continuous double angles on under side of said floor plate.

When the second number is 15,000 and under 18,000, a vertical bulb plate of same depth as main deck beams is to be riveted between two continuous angles on top of said horizontal plate stringer at middle line of ship.

b. When the continuous center keelson extends above the floors, there is to be a horizontal plate stringer on top of floors on each side of vertical keelson, each being in width 1-3 breadth of garboard, and connected to said keelson with continuous fore-aft angles on upper side of said horizontal stringer plate.

When the second number is 18,000 and above, the center keelson must extend above the floors a sufficient height to allow of two top angles with a rider plate, besides the two angles to be secured to the top of horizontal stringer on top of floors.

2. MIDDLE LINE INTERCOSTAL KEELSON.

a. These are to be worked level with top of floors with a bulb plate, 2 inches more in depth than main deck beam, let down below top of floors and riveted to top edge of intercostal plates and embraced by two continuous angles on top of floors. The letting down of the bulb plate may be dispensed with if the intercostal plates are worked high enough above floors to be embraced by the said two floor angles.

b. When used with hanging keels and second number is 13,000 and under 18,000 a vertical keelson plate with double top bars and a rider plate, riveted bewteen the two continuous angles on top of floors is to be worked in lieu of said bulb plate; the depth of vertical keelson to be sufficient to afford a proper working of angles.

When said number is 18,000 or above, said depth to be 3-4 of a specified height.

3. MIDDLE LINE KEELSON ON TOP OF FLOORS.

They are to be worked with double angles and a rider plate on top and connected to floors between double continuous fore-aft angle bars riveted to top of floors embracing said keelson plate. Rider plate to extend at least 3-4 length amidships.

When second number is 33,000 and above, a horizontal stringer plate not less than 18 inches wide must be worked on top of floors under said vertical keelson.

4. FLAT KEEL PLATE WITH MIDDLE LINE KEELSON.

a. When second number is or above 26,000, flat keel plates are to be worked double for 1-2 length amidships. They are to be fitted with an intercostal or a continuous plate keelson.

b. The middle line keelson must be secured to flat keel plates with continuous double angles for a continuous keelson or with intercostal angle clips for an intercostal keelson, and be secured to floors with double clip equal to reverse bars. The top of a continuous keelson to be worked as under 5-1; that of an intercostal keelson as under 5-2.

c. When second number is 13,000 and under 15,000, or when length of vessel is over 10 depths, the top of said keelson must be fitted with double top angles and a rider plate as above. When said number is 15,000 and over, the keelson is to be worked 3-4 of a specified height above floors as above.

6. Frames.

1. At extreme ends of ship lower part of opposite frame angles should be lapped and riveted to each other. Scarph pieces when used at center line to have butts at least 3 feet long and to extend for 3-4 length amidships. Cant frames to be spaced at knuckle not more than the regular frame spacing of ship.

2. In full form vessels frames at forward end between collision bulkhead and 3-5 length should be doubled to turn of bilge; but to margin plate in double bottom vessels.

3. Vertical flange of frame angle on solid floor frames in double bottom vessels may be of same size as horizontal flange of said frame.

7. Floor Plates.

1. For 1-4 length amidship they should extend up the bilges, on outside of frame, above top of keel not less than two times depth of midship floors. To be not less than 1-2 midship depth at 3-4 of half breadth and not less than molding of frames at ends. To be secured to all continuous center line keelson plates with double clips equal to reverse bars.

2. Forward and aft of 1-4 length amidship, the height of floor at bilge may be reduced until floors are straight on top. At ends of ship the center depth is to be gradually increased so as to securely connect the sides. No floor plate is to be of less depth on center line than midship floors.

3. When thickness of midship floors is 9-20 of an inch and above the floor for 1-10 of vessel's length fore-and-aft 3-5 length midship may be 1-20 of an inch less in thickness, and those at extreme ends 2-20 of an inch less in thickness than midship floors.

4. Bulkhead floor plates to be made deeper than other floors to admit of bulkhead plates being riveted to floors above reverse bars.

5. Boiler room floor plates to be 4 pounds heavier, engine room floor plates 2 pounds heavier than midship floor plates.

6. Limber holes to be cut in floors above frames so as to provide a free flow for water.

7. TRANSOM FLOOR to be of same weight, not less at center line than 1 1-2 times depth of midship floors, and to be secured to stern post with double clips equal to frame angles.

8. Reverse Bars.

1. To be fitted to every floor.

2. In topgallant forecastles when second number is 18,000 or above, reverse bars are to extend on alternate frames to said deck, or a double angle stringer is to be worked amid space.

3. Reverse bars to be worked double on every floor in engine and boiler spaces, extending at least from bilge to bilge. When the vessel is or above 17 feet in depth to hold beams, or where second number is 15,000 or above, they are to extend to stringer at upper part of bilge so as to be riveted to same.

4. When second number is or above 20,000, the reverse bars abaft aft peak bulkhead should all extend to upper, spar, or awning deck.

TABLE 2.—EXTENT OF FRAMES AND REVERSE FRAMES.

Type of Ship.	Frames.	Reverse Frames.
One deck vessel	All to upper deck	First number below 45, to upper part of bilges. " " 45 under 57 to U D and S S alternately. Exeept with hold beams, then to U D and top of H B S A alternately.
Two " "	" " " "	
Three " "	" " " "	To upper and main decks on alternate frames.
Spar " "	" " spar "	" spar " " " " "
Awning deck vessel	" " awning " or to bottom of rounded gunwale	All to main deck.
Poop, fo'castle, bridge house decks	" " said deck " " " "	
Raised quarter, sunken fo'castle	All to raised quarter and forcastle deck stringers or to bottom of rounded gunwale	To raised quarter and fo'castle decks on alternate frames.
Sailing vessels	All to upper deck	First number 75 or over. All to upper deck.

Frames to maintain midship scantling for $\frac{3}{8}$ length. Reverse bars throughout. All frames W T Bulkhead to be worked double.
U D = upper deck. S S = side stringer. H B S A = hold beam stringer angle.

9. Bilge, Floor Keelsons, and Side Stringers.

1. BILGE KEELSONS FOR ALL SHIPS.

To be of double angles, riveted back to back, worked at lower turn of bilges. When depth of vessel is 15 1-2 feet or above, a similar keelson to be placed at upper turn of bilges.

2. FLOOR KEELSONS FOR ALL SHIPS.

a. When the second number is 13,000 and under 15,000, a double angle bar floor keelson is to be worked midway between bilges and middle line keelson. When said number is 15,000 and above, intercostal plates are to be worked in connection with said floor keelson, clipped to floors and shell with at least a 3-inch by 3-inch angle clip; but to shell with 3 1-3-inch by 3 1-3-inch clip, if said number is or above 21,700.

b. When size of ship does not require said intercostals, wash plate should be fitted between every floor at quarter beam for 1-2 length amidships.

c. Vessels of full form without inner bottoms should have an intercostal floor keelson between collision bulkhead and 3-5 length.

3. BILGE AND FLOOR KEELSONS AUGMENTATION.—SAILING SHIPS ONLY.

TABLE 3.—FLOOR AND BILGE KEELSONS.

	Steam Vessels.		Sailing Vessels.	
Second Number.	Floor.	Bilge.	Floor.	Bilge.
Under 13,000	......	D A	......	D A
13,000 under 15,0000	D A	D A	D A	D A
15,000 and up	D A + I R	D A	D A + I P	D A
24,000 under 27,000	......	....	D A + I P + B P $\frac{3}{8}$ L	D A + I P $\frac{1}{2}$ L
27,000 " 30,000	......	....	[1] D A + I P + K P T A R P $\frac{2}{3}$ L	D A + I P $\frac{1}{2}$ L + B P $\frac{3}{8}$ L
30,000 " 33,000	......	....	[2] D A + I P + K P T A R P $\frac{2}{3}$ L	D A + I P $\frac{3}{8}$ L + B P $\frac{3}{8}$ L

K P = $\frac{1}{4}$ width middle line keelson. [2] K P = $\frac{1}{3}$ said width.
D A = double angles; I P = intercostal plate; B P = bulb plate; K P = keelson plate; T A = top angles; R P = rider plate.
K P T A R P = keelson plate with top angles and a rider plate; plus sign (+) means *with*; L = length amidship.
Example D A + I P + B P $\frac{3}{8}$ L means; double angle bar stringer with intercostal plates, and a bulb plate for $\frac{3}{8}$ length amidship.

4. SIDE STRINGERS.

a. All vessels with a single beam tier and with second number under 7,200, to have a double angle bar side stringer worked midway between bilges and said deck beams. But when said number is 7,200 and above and vessel is under 15 1-2 feet in depth, two such side stringers are to be worked between bilges and deck beams.

b. For number and arrangement of side stringers see Table 8.

5. When deck or stringer heights at sides is or exceeds 8 feet, additional traverse strength must be provided between stringers or decks.

6. Discontinuous side or bilge keelsons and side stringers should lap each other for at least 3 frame spaces.

10. Floor Clips.

They should be located on every floor throughout holds for all plate and angle bar keelsons and stringers.

11. Continuity of Keelsons.

All middle line, floor, and bilge keelsons should be worked continuously through all water tight bulkheads with water tight staple work.

12. Plate Side Stringers and Beam Stringers.

When worked without beams or when beam spacing exceeds two frame spaces the stringer plate is to have a knee bracket on alternate frames, clipped to shell, with a continuous angle riveted to face of reverse bar, or to reverse slips on frames. When beam spacing is 8 frames or above, stringers are to be connected to said beams with gusset plates, and have single face angles of keelson bar size; or double angles of specified size, with face plates as called for. A single face bar is to be provided in all cases when said stringer is worked without beams. Stringers are to be bracketed to all bulkheads when wide spacing of hold beams are used. When stringers are cut at water tight bulkheads they are to be bracketed to same; bracket plates 1-20 inch heavier than stringer plates, with double clips extending on bulkhead from inside of face bars on frame twice the width of stringer.

13. Web Frames in Engine and Boiler Rooms.

TABLE 4.—SPACING OF WEB FRAMES IN MACHINERY SPACE.

Second Number.	Spacing.
16,000 under 19,000...	At least 3 webs on each side in said space.
18,000 under 30,000...	8 to 10 feet apart.
30,000 and up........	Not more than 8 feet apart.

They should be fitted to beam frames if possible; otherwise to have brackets above and below stringer plate in way of said webs. When hold beams are omitted in said spaces, said web frames are to be spaced closer than above.

14. Web Frames with Deep Side Stringers in Lieu of Hold Beams.

1. They should equal thickness of vertical flange of frame to which the webs are connected. Double angle bars equal to reverse bars are to be worked on faces of web frames and stringers. (Face bars may be worked single if of extra heavy scantling with double clip at diamond plate connections to side stringers). Web frames to be attached to double bottom margin plate with double clips. All side stringers to be worked intercostally and have double clips to webs.

TABLE 5.—SIZE OF DIAMOND PLATES.

Depth of web.....................	14″	15″	over 15″
Size diamond plate.............	24″ × 18″	30″ × 21″	30″ × 24″

2. Side stringers 18 inches or above in width, with web frames more than 8 feet apart must have knee brackets to frames midway between webs.

TABLE 6.—WEB FRAMES AND STRINGERS IN LIEU OF HOLD BEAMS.

Center Depth to Lowest Tier Regular Beams.	Center Depth to middle deck 3-deck vessel.	Width of Web.	Spacing Frames.	No. of Stringers.	Notes.
Feet under 16	......	14″	8	1	....
16 " 17	......	15	8	1	....
17 " 18	Feet	15	8	2	Omit bilge stringer.
......	17 under 18	15	6	2	Except awning deck, vessels omit bilge stringer.
18 " 21½	......	15	6	2	....
......	18 " 21½	18	6	2	Awning deck vessels 16″ web.
21½ " 22½	......	15	6	3	....
21½ " 22½	......	18	6	2	In double bottom vessels with margin bracket up bilge 3 floor depths.
......	21½ " 22½	18	6	3	Awning deck vessels 16″ web.
22½ " 23½	......	16	6	3	....
......	22½ " 23½	18	6	3	Awning deck vessels 16″ web.
23½ " 24	......	18	6	3	....
To Raised Quarter Deck, Feet.	24 " 25	16	5	3	4 hold beams and a W T bh. between aft engine room bh. and aft end of ship.
	25 " 26	16	4-5	3	
	26 " 27	18	4	3	
	27 " 28	18	4	4	

Depth taken from top of keel to top of first complete tier of beams other than wide-spaced beams.

15. Deep Framing for Vessels in Lieu of Web Frames.

1. Deep frame angle to have a 3-inch single riveted lap to regular frame angle. Knee brackets to lowest deck beams should be three times depth of beams. Side stringers should be bracketed to bulkheads. The size of brackets varying whether side stringers are worked continuously or are cut. Reverse bars should extend to upper deck in two-deck vessels; otherwise as stated in Section 8. Web frames in machinery space to be spaced about 10 frames apart.

TABLE 7.—NUMBER OF PLATE SIDE STRINGERS.

Depth to lowest tier of regular beams..........	Under 17′	17′ under 21½′	21½′ under 24½′
Number of plate side stringers.................	1	2	3

16. Deck and Hold Beams.

1. They should be located vertically over each other and as far as possible on frames which have their reverse bars carried up to decks.

2. All deck beams with a steel or wooden deck laid thereupon to be placed on alternate frames. When a steel deck, without wood decking, is less than 7-16 inches thick they should be placed on every frame. Short beams at hatches, engine, and boiler openings, should be fitted to every frame when no wood decking is laid on a steel deck.

3. Deck beams under a water-tight flat to be fitted on every frame.

4. Orlop or lower deck beams of sailing vessels to be 1 inch deeper than beams of upper deck of same length.

5. Through beams attached to deep web frames to be extra heavy when no steel deck is laid thereupon. Half beams to have large plate brackets to head of deep web frames.

TABLE 8.—SPACING OF DECK BEAMS AND TYPE OF HOLD STRINGERS.

Depths from top of keel to				Upper Deck.	Main or Middle Deck.		Lower Deck.		Orlop Deck.	
Class.	Upper Spar Awning.	Main on Middle.	Lower.	Beams.	Beams.	Stringers.	Beams.	Stringers.	Beams.	Stringers.
All....	Under 13*	....	....	Alt.	....	Double angles.	....	....	....	....
"	13 " 14	....	....	"	....	D A+B P 3/8 L D A+I P 3 L	....	....	....	....
"	14 " 15½	....	....	"	....	D A+12″ I P+D F A	....	....	....	....
"	15½ " 16½	....	....	"	10 E	Plate	....	....	....	....
"	16½ " 17½	....	....	"	10 E	P S+S F A	....	....	....	....
"	17½ " 18½	....	....	"	10 E 2+4 Alt.	PS+S F A Plate.	....	....	....	....
"	18½ " 19½	....	....	"	10 E 2+4 Alt.	P S+D F A 3½″×3½″+F P Plate.	....	....	....	....
Sail...	19½ " 23	....	....	"	Alt.	Plate.	....	....	....	....
"	23 " 24	16 under 17	....	"	"	"	....	Double angle.	....	Double angle.
"	24 " 26	17 " 18	....	"	"	"	....	D A+B P	....	D A+B P
"	26 " 27	18 " 19	....	"	"	"	....	D A+B P+I P	....	D A+B P+I P
"	27 " 28½	19 " 20½	....	"	"	"	....	Orlop stringer plate S F A Three D A+B P+I P stringers.		
"	28½ " 29½	20½ " 21½	....	"	"	"	10 E 12 E	P S+S F A P S+D F A 4″×3½″+F P	....	....
Steam.	19½ " 22	....	....	"	Alt. 8 E 10 E	Plate P S+S F A P S+D F A 3½″×3½″+F P	....	...	....	....
"	22 " 23	....	....	"	Alt. 8 E 10 E	Plate P S+S F A P S+D F A 3½″×3½″+F P	....	Double angle.	....	....
"	23 " 24	....	....	"	Alt. 8 E 10 E	Plate P S+S F A P S+D F A 3½″×3½″+F P	....	D A+B P	....	....
"	24 " 26	17 " 18	....	"	Alt.	Plate.	10 E	P S+S F A		
"	26 " 27	18 " 19	....	"	"	"	2+4 Alt. 8 E 10 E	Plate P S+S F A P S+D F A 3½″×3½″+F P	....	....
"	27 " 28	19 " 20	....	"	"	"	2+4 Alt. 8 E 10 E	Plate P S+S F A P S+D F A 4″×3½″+F P	....	....
"	28 " 30	20 " 22	....	"	"	"	Alt. 8 E 10 E	Plate P S+S F A P S+D F A 4″×4″+F P	....	....
"	30 " 32½	22 " 24½	....	"	"	"	Alt. 8 E 10 E	Plate P S+S F A P S+D F A 4″×4″+F P	....	D A+B P
"	32½ " 36	....	17½ under 21	"	"	"	Alt.	Plate.	....	P S+S F A
"	36 " 39	....	21 up.	"	"	"	"	"	10 E	P S+D F A

Single face bars to equal keelson bars. Bulb plates to equal depth of deck beam.
* To top of main-deck beams in awning-decked vessels of less than 7½ feet in depth.
D A = double angle; B P = bulb plate; I P = intercostal plate; D F A = double face angle; P S = plate stringer; S E A = single face angle; F P = face plate; E = extra heavy.
Alt = alternate frames: 2 + 4 = second and fourth frames alternately: 8E = on every eighth frame, if extra heavy beams are used: plus sign (+) means *with*.
Example: P S + D F A 3½″ x 3½″ + F P means: plate stringer with 3½″ + 3½″ double face angle and a face plate.

17. Beam Knees.

1. Welded or plate beam knees to be not less than three beam depths, as follows:
a. Upper deck beams on steamers having only one tier of beams.
b. Middle deck beams on steamers having deep frames or web frames in lieu of a tier of beams.
c. When beams are supported by three rows of pillars.
d. Upper deck beams in way of omitted middle deck half beams.
e. Deck beams in water-tight flats and peak tanks.
f. Upper decks, lower decks, orlop deck beams of sailing ship.
2. When two rows of beam pillars are fitted, 2 3-4 depth of beam. In all other cases, 2 1-2 depth of beam Knees to be not less than 6-10 of depth across throat.

TABLE 9.—RIVETING OF BEAM KNEES.

Depth of Knees.	Rivets.	
	No.	Dia.
Under 17 inches	4	¾
17 inches and under 21 inches	5	¾
21 inches and under 24 inches	5	⅞
24 inches and under 28 inches	6	⅞
28 inches and under 32 inches	7	⅞
32 inches and under 36 inches	8	⅞
36 inches and under 40 inches	9	⅞

18. Deck Plating, Stringer, and Tie Plates.

1. Upper decks to be plated in way of hatches 22 feet or more in length, with plating tapering to deck stringer. When either the engine or boiler opening exceeds 15 feet or combined length of both exceeds 30 feet, the beams in way of same should be plated over, the plating extending two beam spaces beyond the openings and tapering thence to stringer plate for a distance equal to width of plating required to be fitted. When large openings are adjacent the deck space between should be plated.

2. When a full or half deck is required, it is to be fitted to upper decks in one and two-deck vessels and to the middle or upper deck in three and spar-deck vessels. (Steel decks should be increased in weight at all deck openings, with doubling plates at corners of large deck openings.)

3. When a half steel deck is laid it is to maintain the full breadth of ship for 1-2 length amidships and thence taper at each end for 1-8 of vessel's length into deck stringer.

4. When only one steel deck is called for, the stringer plate may be reduced in width one inch for every 7 feet of ship's length. Orlop stringer plates to be 3-4 width of lower hold beam stringer plate.

5. Stringer plates to maintain full midship size for 1-2 length amidships.

6. Fore-aft tie plates to be worked on each beam tier at side of hatches. When hatch ways are 16 to 20 feet in length the width of said plates to be double that for hatch of ordinary width, extending for a length of two beam spaces beyond each end of hatch.

a. Diagonal tie plates at mast partners of sailing vessels to be of same weight as corresponding deck stringer; and in said vessels, whose second number is or above 15,000, to be fitted on upper deck throughout.

7. Steel decks should be fitted on bulb beams when fitted to alternate frames in vessels of over 34 feet beam.

8. Mast Partners.—Plates to equal deck stringer in weight and be not less than 3 mast dias. in width. Rings for sailing vessels to be 1 inch deeper than required for bulb angle frames. For steamer rings to equal frame angle.

19. Stanchions.

TABLE 10.—ROWS OF STANCHIONS AND NUMBER OF RIVETS IN EACH END.

Beam Length Amidships.	Rows of Stanchions.	Stanchions. No. and Size Rivets.		
		Length or	Dias.	
Over 43′	2	10′ under 18′	$2\frac{5}{8}$″ under 4″	Two $\frac{7}{8}$″
Over 55′	3	18′ " 24′	4″ or over.	" 1″
....	....	over 24′	....	Three 1″

1. When beams are spaced on every frame, stanchions are to be fitted at alternate beams, with a double angle strong back, equal to reverse bars, worked under said beams and clipped to same.

2. In deep tank, with center line bulkhead, a row of quarter stanchions attached to an intercostal girder is to be used.

3. Additional stanchions to be placed under deck houses, heel of bowsprit, windlass, steam winches, and capstans.

4. Bulwark stanchions to be spaced not more than 6 feet apart, and in sailing vessels of 1,800 tons or over not more than 4 to 5 feet apart. To be from 1 3-8 inches to 2 inches diameter, with four 7-8-inch rivets or taps at heel. To have spur to bulwark with doubling plate at same.

20. Bulkheads.

1. Forward collision bulkhead worked to upper, spar, or awning deck to be at least 1-20 vessel's length aft of stem. Aft collision bulkhead to be at a reasonable distance forward of stern. A water-tight bulkhead shall be fitted at each end of machinery space.

TABLE 11.—NUMBER OF W. T. BULKHEADS IN CARGO SPACES AND TOTAL NUMBER IN SHIP.

Length of Ship.	220′* under 280′	280′ under 330′	330′ under 400′	400′ under 470′	470′ under 540′	540′ under 600′	600′ under
Forward cargo space........	1	1	1	2	2	3	
Aft cargo space..............	0	0	1	1	2	2	
Total in ship................	4	5	6	7	8	9	

* Machinery placed aft.

2. Said cargo and machinery space bulkheads to be carried up to upper decks of vessels having one, two, or three decks; to spar deck in spar-deck vessels, and to main deck in awning-deck vessels. The latter having deep web frames worked between decks over bulkheads below.

3. All frames on water-tight bulkheads shall be doubled. All angles connecting bulkheads to decks or double bottom plating are to be doubled and equal to reverse frames.

4. Stiffeners on hold bulkhead to be of angle bars equal to size of main frames, worked vertically on one side, not more than 2 feet 6 inches apart, and horizontally on the other not more than 4 feet apart. Vertical stiffeners to be well secured to floor plates, or where double bottoms are used to be bracketed to same. When bulb angles are used for horizontal stiffeners they are to be bracketed to shell.

5. Bulkhead shell liners are to be wide enough to take the frames forward and aft of bulkhead frame, or they may be of approved diamond shape.

6. All collision bulkheads, and all other bulkheads 40 feet or above in breadth shall have their horizontal stiffeners of bulb angles 1 inch deeper than specified for bulb frames. They shall be bracketed to shell. All bulkheads of 36 feet and under 45 feet in width to have in addition a vertical web plate at center, from center keelson to lower deck beams. When of 45 feet and under 55 feet in width to have two such web plate stiffeners. When of 55 feet and over 60 feet in width to have three such web plate stiffeners.

7. Sailing ships need have but the forward collision bulkhead.

8. Center line bulkheads shall have vertical stiffeners on each side two frame spaces apart. Those on one side being attached to beams. They are to have double top and bottom angles of at least 3 inches by 3 inches by 7-16 inch.

9. Bulkheads in vessels requiring lower deck, hold, or orlop beams, which are not supported on both sides by a lower or orlop deck, to have a semi-box girder horizontal stiffener. When web frames are used in lieu of hold beams all transverse bulkheads are to have a center vertical web and semi-box beam in addition to regular stiffeners.

10. Bulkheads at fore end of all bridge houses and of poop extending over engine and boiler or other deck openings to have a coaming—plate higher and 2 pounds heavier than plating. Plating to equal that of bridge house side plating and be stiffened with bulb beams 1 inch deeper than required for bulb angle frames, 30 inches apart, bracketed at each end to decks. If said poop or bridge house does not extend over a boiler, engine, or other opening the stiffener may be of angle bars 30 inches apart.

11. Bulkheads at front of brake of a raised quarter deck are to have an athwart ship stiffener plate, equal to upper deck beam tie plates, riveted at ends to deck ends with brackets to bulkhead's stiffening angles. Said bulkhead plating to equal that of bridge house side plating and have angle stiffeners equal to frames, 30 inches apart.

21. Shaft Tunnel.

Plating to equal that of lower half of bulkheads. Stiffeners to be spaced not more than 4 feet apart (3 feet under hatches), and equal to reverse bars. Stiffeners on recess at aft end to be spaced as frames. Top of tunnel under hatches to be 2-20 inch thicker than rest or have a 2-inch wood covering. Water-tight doors at forward end, to work from upper deck. When stanchions to beams are located on shaft tunnel, the tunnel must have additional stiffening at said point.

22. Breast Hooks.

1. Side stringers in end peaks should be spaced about 4 feet apart. When second number is or over 24,000 breast hooks to be fitted between each deck tier, at both ends. Depth for regulating the tier of alternate frame deck or panting beams in fore peaks to be taken at forward collision bulkhead. Rules under Section 16 to regulate said beams.

2. Sailing Vessels under 20 feet depth at collision bulkhead to have lower deck or panting beams at alternate frames. When said depth is 20 feet and under 30 1-2 feet, to have additional tier of panting beams below lower deck tier. When said depth is 30 1-2 feet and under 33 feet to have two tier of panting beams below lower deck tier. Stringer plates on panting beams should extend aft of collision bulkhead 1-4 of vessel's amidship beam and be in width 2-3 of midship width of lower deck stringer.

23. Shell Plating.

1. Plates should not be less than 6 frame spaces in length except at ends. To maintain midships weight for 1-2 length amidships. Forward and aft of said 1-2 length the plating may be gradually reduced by 1-20 of an inch to thickness specified for plating at extreme end. In sailing vessels, the overlapping strakes for 1-4 length at forward end are to be only 1-20 of an inch less in thickness than midship plates.

2. Butt of adjoining strakes to be at least 2 frame spaces apart; of alternate strakes 1 frame space. Butts of garboards to be shifted clean of keel scarphs and of each other at least 2 frame spaces. Butt of deck stringers should be at least 2 frame spaces from butts of their sheer strakes.

3. Sheer strakes of one, two, three, and of spar-deck vessels to extend above gunwale bar to allow of two horizontal rows of rivets in butt straps above said bar.

4. (*a*) Boss plates are to be at least the same weight as the midship plates of the same strakes. When second number is 13,900 and under 26,500 said plates to be 1-20th heavier than midship plates, and have treble-riveted butts if said number is 18,700 and under 26,500. When said number is 26,500 and over, said boss plate and the one below and above to be 2-20-inch heavier than the midship plates, with treble-riveted double straps, or boss plates are to be worked double. (*b*) Garboard plates to stern post in screw vessels to be of the same weight as those amidship. In vessels whose second number is 16,600 or above, all plates connecting to stern post to have same weight as their respective strakes amidships.

5. In ships of full form the two strakes next to garboards to maintain full midship weight up to collision bulkhead.

6. Sailing vessels to have three bilge strakes increased 1-20 inch, all fore-aft, when second number is 16,000 and above. When said number is 22,000 or above the strakes in way of hold beams are to be also increased 1-20 inch for 1-2 length amidships.

7. When scuttles are fitted in sheer strake within 3-5 length amidships additional strength must be provided at said point.

24. Butt Straps.

1. Single butt straps to at least equal the thickness of plates they connect.
   Double butt straps to be 3-20 inch thicker than 1-2 thickness of plates they connect.
2. Butt angle straps to keelsons bars must be at least 2 feet long.
3. Butt straps of all vertical keelson plates, floors, and web frames must be worked double.
4. Butt straps of flat keel plates to be as much thicker than keel plates as is required for bilge strakes.
5. Butt straps for masts to be 1-20 inch thicker for double riveting and 2-20 inch for triple riveting than plates they connect. They should be fitted on outside of masts and bowsprits. Straps of topmasts to be 1-20 inch thicker than plates they connect.
6. Shell and Deck Stringers.. Also see Table 13.

a. When outside strake plates are above 40 inches and not over 46 inches in width, or the inside strake plates are 48 inches and not over 54 inches in width, their straps are to be 1-20 inch thicker than plates they connect, unless they are specified to be 4-20 inch, as stated in table 13.

(To be continued.)

New Tug Boat Cornell.

The latest addition to the fleet of the Cornell Steamboat Company is the steel tug boat *Cornell*, recently completed at the yard of the Townsend-Downey Company from designs prepared by Mr. J. A. Hargan. The dimensions of the vessel are not given, but suffice it to say that she is of the largest type of sea-going tug boat. The hull is built of steel throughout and subdivided into five water-tight compartments by four thwartship bulkheads. The frames are spaced 22 inches, center to center, and are of angles 3 1-2 by 3 inches by 7 pounds. The deck beams are of channel bars 6 by 2.81 by 2.81 inches by 13.3 pounds and are placed at every frame. The stem and stern posts are of the best hammered iron, the former 7 by 2 1-4 inches in section, and the latter 7 1-2 by 2 3-4 inches. The flat plate keel is 44 inches wide by 18 1-2 pounds weight per foot. The bilge plating is 17 1-2 pounds, the sides and bottom are laid with 15-pound plates, and the shear strake is 18 1-2 pounds. The deck is laid with yellow pine, 3 1-2 by 3 1-2 inches.

The compound condensing engine was built by the Cornell Steamboat Company at the Rondout shops. The high-pressure cylinder is 20 inches diameter and fitted with a piston valve; the low-pressure cylinder, 53 inches in diameter, has a flat, double-ported slide valve. The cut-off in the high-pressure is 22 1-2 inches and in the low-pressure 22 inches. The common stroke is 36 inches. A complete set of Blake pumps is installed, and the air pump is independent, of the same make. The propeller is of cast iron, 10 feet 3 inches diameter by 15 feet pitch, with 4 blades of maximum width, 56 inches. When towing, the engines making 97 revolutions, indicate about 1,390 horse power; while when running light, at 135 revolutions, the horse power is 1,934, and the speed in the neighborhood of 18 miles. The total fuel capacity is 190 tons, and it is stated that 3,480 pounds of buckwheat anthracite are burned per hour when the vessel is towing, and 4,835 pounds when running light.

Steam is supplied by two single-end Scotch boilers, built by Richard Hammond, of Buffalo, N. Y., 12 feet 1 3-8 inches long by 14 feet 9 inches mean diameter, for a working pressure of 180 pounds. The average pressure carried at the boilers is 175 pounds, which is reduced 5 pounds at the engines. Each boiler is fitted with three Morison suspension furnaces, 46 inches inside diameter. The donkey boiler, located in the deck house, midship, is the vertical tubular type, 36 inches diameter by 5 feet 10 inches high.

The vessel is lighted throughout by electricity generated by a direct-connected, 7 1-2 Kw. set, of the General Electric make. The deck machinery includes an American ship windlass and capstan, and a Williamson steam and hand-steering gear.

OBITUARY.

Mr. John Edwin Thropp died at his home in Trenton, N. J., on November 24, 1904. Mr. Thropp was prominently identified in the trade of marine engine builders for many years, and established the firm of John E. Thropp Sons Company, of which he was president at the time of his death.

Mr. James H. Williams died on December 8, at his home, 6 Pierrepont street, Brooklyn. Mr. Williams was born in Fort Plain, N. Y., fifty-nine years ago. He was prominently connected with James H. Williams & Company, of Brooklyn, manufacturers of drop forgings, which he established in 1883.

Report of Boiler Makers and Iron Shipbuilders.—The report of the boiler makers and iron shipbuilders is disheartening, from the state of trade point of view, says *London Engineering*. There is very little as yet to indicate any improvement in trade, but the report states that there is a more hopeful feeling in some districts, and it is thought that a revival is near at hand. The quarterly report shows a total membership of 48,804. The union has been supporting a vast army of sick, unemployed, and superannuated members to the extent of 9,964.

QUERIES AND ANSWERS.

All reasonable questions concerning marine engineering received from and signed by subscribers will be answered by the editor in this column. All communications must bear the name and address of the writer.

Q. 258.—Please answer in your next issue the following questions: I have a launch of the torpedo type, 30 feet long, 6 feet beam, with a draft light—12 inches—which I built myself. It is very light, bow rather fine lines; of course the propeller hangs a little below the keel. I also have an engine of two cylinders, of the four-cycle type, bore 5 1-4 by 6 inches stroke, which, when running at 900 revolutions, gives a brake horse power of 12. The hull alone weighs 1,800 pounds. Can I run a propeller at this speed with good results? If so what size of pitch and number of blades shall I use and at what speed should I expect the boat to run?

A.—In lack of information, we assume that your engine will weigh 500 pounds; that your gasoline stores and equipment will weigh 200; and that the two persons on board will weigh 300, making a total weight of hull, machinery, and load, of 2,800 pounds. With a well-designed, lightly-built hull, a high-speed engine of 12 horse power should be able to drive this boat at a speed of about 12 1-2 miles per hour.

There is no difficulty in designing a propeller to run at 900 revolutions—in fact, higher speeds than this are now being considered*—but we, however, would not recommend very much over 1,000, owing to cavitation, which sets in at excessive speeds. With the power and revolutions stated, a four-bladed wheel of about 16 inches diameter and 19 inches pitch should prove to be about right. The blades should be elliptical and their combined developed area should be about 38 per cent., the area of a disk of the same diameter. An engine designed for 900 revolutions would probably not give satisfaction when running at much greater speeds, as there will be too excessive wire drawing of the gases passing through the valves, and you may expect difficulty with your carburetor and igniter. There may be structural reasons why your engine should not be run at an excessive speed, and in regard to this point the manufacturer should be consulted.

Q. 267.—Please tell me in the Q. & A. column what I would gain by coiling my feed pipe around in the steam space of the boiler, before it discharges into the water. W. D. H.

A.—The advantage to be gained by coiling your feed pipe in the steam space of boiler would be that the feed would be brought to a high temperature before discharging into the boiler, providing the coil was sufficiently long. This would mean that there would be less internal strain upon the boiler due to unequal temperatures of cold feed. This system alone is hardly sufficient, as there is no provision made for removing the mud or scale-forming deposit which generally comes with heating the water. Another objection is that the feed can in no way be heated until after steam is raised, and cannot be of service, such as the hydrokineter, for circulating the water in the boiler while raising steam. These remarks apply alone to large boilers, for such requirements are scarcely considered necessary in small boilers. We would refer you to two articles on feed water heaters which recently appeared in Marine Engineering, one on the internal coil type, page 386, July, 1903; another on somewhat similar design, page 90, February, 1904.

Q. 268.—Please answer the following question through Marine Engineering and oblige. What amount of coal, in tons, does the *Kaiser Wilhelm II.* consume per day when crossing the Atlantic, *i.e.*, approximately, her consumption for 24 hours? R. K. B.

A.—The indicated horse power of the main engines of the *Kaiser Wilhelm II.* is about 38,000. Assuming that for all purposes 1 3-4 pounds of coal per I. H. P. of main engines are burned, this means that about 30 tons per hour, or 720 tons per day are shoveled into the furnaces.

*See paper of Lieut. W. D. Taylor, presented before the November meeting of the Society of Naval Architects and Marine Engineers. The discussion appeared in the December, 1904, issue of Marine Engineering.

Q. 269.—Will you please answer in your Q. & A. column the following question: Suppose we have a compound engine 12 by 24 by 20 inches, boiler pressure 110, and a pressure of 4 pounds on the low-pressure cylinder, having no cut-off on the low-pressure cylinder, we will put one on and cut it off till we have a pressure of 16 pounds on the low-pressure cylinder. Am I gaining anything? I cannot see as I am. I should think that it would make more of a back pressure for the high to carry. W. M. F.

A.—If by "4 pounds on the low-pressure" you mean an exhaust pressure of 4 pounds, your calculations are correct. The higher the back pressure the more you will cut down the power of the engine. You can readily see this by assuming a still more exaggerated case than yours—for instance, that the back pressure will be 75 pounds. The effective pressure of the engine is determined, among other conditions, by the range of pressures—that is, the difference between the admission and the exhaust pressures. In your case it is 110 — 16 = 94 pounds. As a matter of fact, 1 pound pressure at the lower end of the expansion is more effective than it is at the initial end. For instance, if you reduce your back pressure from 4 to 3 pounds, you have an added effective pressure of 1 pound working in your low cylinder. As the area of the low is four times the area of the high, this pound of pressure will give, relatively speaking, four times the amount of work as 1 pound increased initial pressure in the high-pressure cylinder. This is not strictly correct, but serves for illustrating the point.

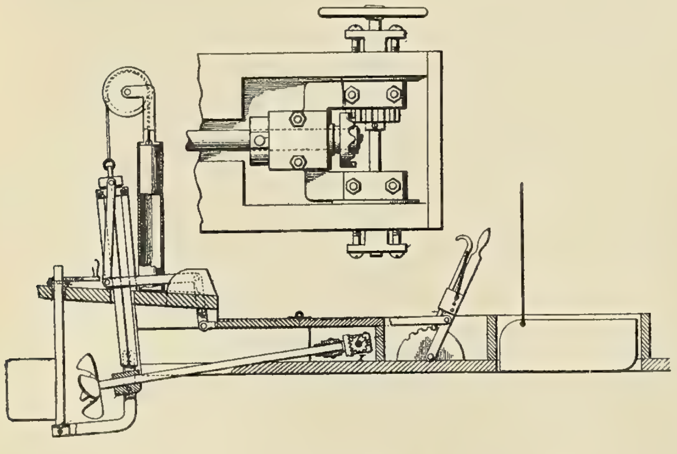
Ferryboats.—Ferryboats which ply between Oakland and San Francisco are the largest of this type of boat in the United States. The first of these large boats was built in 1898. It is propelled by triple-expansion engines, is 284 feet long, has a 64-foot beam, 17 feet depth of hold, and 1,945 gross tons of displacement.

SELECTED MARINE PATENTS.

772,383. WATER MOTOR. HERMANN J. M. SIEMERS, HAMBURG-HORN, GERMANY.

Claim.—1. In a water motor, the combination of a body provided with air chambers, with a water-inlet valve, and a suction pipe having a perforated lower end and adapted to close said valve. Three claims.

772,384. BOAT AND PROPELLING MEANS THEREFOR. FREDERICK W. SMITH, ELLSWORTH, MICH.

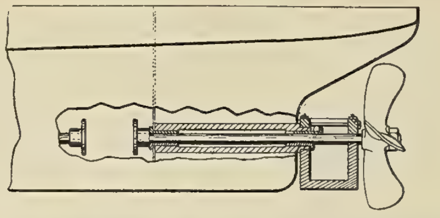


Claim.—1. The combination, in a boat, of a shallow body having an elevated deck on its rear portion, a hanger movable up and down through the elevated deck of the body, suitable means for adjustably fixing the said hanger, a propeller carried by and movable with the hanger, and means connected with the propeller for transmitting rotary motion to the same.

772,970. BUOYANCY-REGULATING APPARATUS FOR SUBMARINE BOATS. LAWRENCE Y. SPEAR, GREENPORT, N. Y., ASSIGNOR TO ELECTRIC BOAT COMPANY, NEW YORK, N. Y.

Claim.—1. A submarine boat having means for regulating and maintaining the reserve or surplus buoyancy of the boat, said means comprising a plurality of connected adjusting tanks of known capacity, means for filling one or more of said tanks from water of flotation, means for blowing out the water from one or more of said tanks, and gauges, actuated by a hydrometer, showing the weight required to put the boat in diving trim and the changes in displacement due to differences in the specific gravity of the water of flotation.

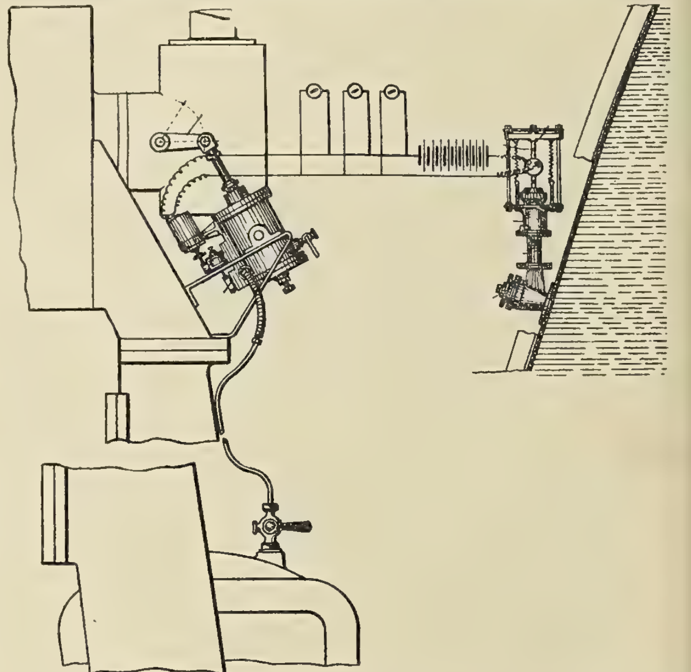
773,036. APPARATUS FOR RENEWING THE STERN BUSHINGS OF SHIP PROPELLER SHAFTS. HERMAN SMITH, LUDINGTON, MICHIGAN.



Claim.—1. The combination with a ship of a removable receptacle open at the top and located between the propeller wheel and the stern wall of the ship, with the propeller shaft extending through suitable apertures in the wall of the receptacle and with the shaft tube fitting and projecting into the aperture of the inner receptacle wall.

773,079. MARINE-ENGINE GOVERNOR. ANDREW KERR, NEW BRIGHTON, ENGLAND.

Claim.—1. In an automatic governor for marine engines, the combination of a cylinder arranged below the water-level in the tunnel of a ship, near the propeller, and having a plurality of water inlets connected therewith, a cock for controlling the escape of air from the cylinder, a water-tight piston within the cylinder having a plurality of arms mounted

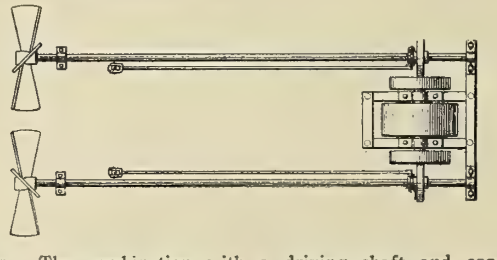


on its rod outside of said cylinder, a bar connected to and projecting on opposite sides of said piston rod and engaging suitable stationary guides, springs adjustably connected to said bar on opposite sides of the piston-rod and adapted to regulate the stroke of the piston, an electric switch having pawls projecting into the path of the arms on the piston-rod, means for controlling the supply of steam to the engine, a source of electricity, and an electric circuit including said source of electricity, said switch, and said means for supplying steam to the engine.

773,146. SUBMARINE VESSEL. WILLIAM HUGUET, LOUIS MINART AND FRANCOIS MIRON, PARIS, FRANCE.

Claim.—1. A submarine apparatus provided with external tools and electric motors, and having a perfectly-water-tight shell without any moving parts passing through it, whereby the external tools may be operated under water at great depths while the internal pressure is only that of the atmosphere.

773,615. FRICTIONAL GEARING FOR MOTORS. EDWARD W. WICKEY, EAST CHICAGO, IND.



Claim.—1. The combination with a driving shaft and opposite frictional disks perpendicular thereto, of oppositely disposed frictional pinions perpendicular to and bearing upon said disks, whereby the pressure of one pinion balances that of the other, and means for moving said pinions radially upon the disks independently of each other and across the center of the frictional surfaces.

773,285. DEVICE FOR UTILIZING THE POWER OF UNDULATIONS OF WAVES OF THE SEA. FRITZ GOEDECKE, TELTOW, NEAR BERLIN, GERMANY.

Claim.—1. The combination with a screw spindle, of a float guided to move vertically, a clutch, and a sleeve on the spindle adapted to be engaged by the clutch and drive the spindle, substantially as and for the purposes set forth.

Marine Engineering

Vol. X. FEBRUARY, 1905. No 2.

TRIAL TRIP OF THE CHATTANOOGA.

The United States cruiser *Chattanooga* exceeded her contract speed of 16.5 knots on her official trial off Cape Ann, Mass., December 31, making an average of 16.605 knots in a continuous run of four hours in open water. The trial board were enthusiastic in their praise of the boat. The wind blew lightly from the west, and the sea was comparatively flat, the general weather conditions being nearly perfect. Her engines worked evenly and on the whole perfectly throughout. The *Chattanooga* was next put through an endurance test of 24 hours, returning to Newport, R. I., January 4, in a severe storm, which tested the capabilities of the vessel in a manner not down on the trial programme, and the vessel proved herself a staunch sea boat.

The *Chattanooga* is a sheathed semi-protected cruiser of 3,200 tons displacement, 292 feet long, 44 feet wide, and drawing 15 feet 9 inches. She is one of the six ships known as the *Denver* class, the other four being the *Galveston, Tacoma, Cleveland,* and *Des Moines*, and is the last of the six to be completed. She is fitted with twin-screw, vertical triple-expansion engines designed to develop 4,700 horse power, and to give her a speed of 16 1-2 knots. Each engine has four cylinders, with diameters respectively 18, 29, 35 1-2, and 35 1-2 inches, and a common stroke of 30 inches. Steam is generated by six Babcock and Wilcox water-tube boilers with an aggregate grate area of 300 square feet and a total heating surface of 13,200 square feet, the ratio of heating surface to grate area being thus 44 to 1. The total weight of all machinery, with water in the boilers and condensers, is 405 tons. The normal coal supply is 467 tons, but bunker capacity is provided for a total of 800 tons, which, at a speed of ten knots,

THE CRUISER CHATTANOOGA.

[Photograph copyright by E. Muller.]

is estimated to provide a steaming radius of 6,925 nautical miles. The main battery consists of ten 5-inch rapid-firing guns; the secondary battery of eight 6-pounders, two 1-pounders, four Colt automatic guns, and one 3-inch field gun. The crew numbers 19 officers and 308 men. There is a protective deck which measures 2 inches on the thickest part of the slopes and 1 inch on the balance.

The *Chattanooga* was authorized by act of congress approved March 3, 1899, and a contract was entered into on December 14 of that year, with the Crescent Shipyard at Elizabethport, N. J., the price of hull and machinery to be $1,039,966. The keel was laid on the 29th of March, 1900, and after many delays the ship was launched on March 7, 1903, her contract date of completion having been June 14, 1902. When the shipbuilding trust, of which the Crescent Shipyard was a member, collapsed, the vessel was taken possession of by the government, and on September 15, 1903, the contract was declared forfeited. A month later the ship was removed to the government yard at New York for completion, it being estimated at the end of the last fiscal year that the hull was about 89 per cent. finished.

MARINE ENGINEERING DATA CARD. FEBRUARY, 1905.

NAME—Chattanooga. NATIONALITY—American. TYPE—Semi-protected cruiser.

LAUNCHED—1903. BUILDERS—Crescent Shipyard and United States Navy Yard, Brooklyn. OWNER—United States Navy.

Length on water line	292 ft. 0 ins.	Total heating surface	13, 200 sq. ft.
Breadth, molded	44 " 0 "	Ratio	44 to 1
Draught, mean	15 " 9 "	Horsepower per square foot of grate	15.67
Displacement	3 200 tons	Square feet of heating surface per horse-power	2.81
Block coefficient	0.554	Indicated horsepower, designed	4,700
Engines: Two, four-cylinder triple expansion		Total machinery weights	405 tons
Cylinders	18, 29, (2) 35 1-2 ins.	Horsepower per ton of machinery	11.6
Stroke	30 "	Speed in knots, designed	16.5
Boilers:		Admiralty coefficient	207
Six Babcock and Wilcox water-tube.		Normal coal supply	467 tons
Total grate area	300 sq. ft.	Total bunker capacity	800 "

A Turbine Steamer.—The following lucid statement appears in a recent issue of the *Baltimore News:*

"*To Editor Woman's Inquiry Column:*

"What are the specifications of a turbine steamer?

"IGNORANCE."

"I suppose you mean what are the distinctive features of a turbine steamer. There is only one important difference between a turbine and a propeller. The former is a side-wheeler, the latter has the wheel in the rear of the boat."

PRACTICAL POINTS ABOUT THE SCREW PROPELLER.

BY W. F. DURAND.

PART II.

LAYING DOWN A SCREW PROPELLER ON THE DRAWING BOARD.

Having considered in the preceding chapter the various types and forms which the screw propeller may take, we come next to the problem of the delineation or laying down of the propeller on the drawing board. We assume for the first example a propeller of simple type, solid hub and blades, uniform pitch, and with blades at right angles to the axis and symmetrical in form about the blade center line. Now, it must be remembered, that in all cases of propeller delineation the following items are indispensable to the molder or pattern maker:

(1) Information serving to determine the area and contour of the blade.

(2) Information serving to determine the pitch.

(3) Information serving to determine the blade thickness and its distribution.

(4) Information serving to determine the hub.

Any information beyond that needed for these purposes is, as a rule, quite unnecessary, though occasionally the various projected views may be of value with reference to questions of clearance relative to stern post or arch of propeller well. Having in view then the above schedule of information, we may proceed as follows:

In Fig. 16 draw XY to denote the shaft center line, and OU a line at right angles with it, on which lay off a distance OC to represent the radius. Then lay off the diameter and length of the hub and put in the hub contour as shown. This is to be considered only a first approximation to the hub, especially as regards length, which may be modified later as the blade dimensions may require. We are now ready to determine No. (1), the blade area and contour.

The area numerically has been specified by the designer so that its amount is known in square feet. Suppose that we are dealing with a three-bladed propeller; then, since the blades are symmetrical about the blade center line OC, the area to be inclosed by the half blade contour $FCDE$ is known in square feet as one-sixth the total amount. We then divide this area by the distance FC or length of the blade in feet. The quotient will give the width of a rectangle of area equal to that of the half blade desired. Lay off this width, represented by CG, and draw GH. Then the rectangle $FCGH$ contains the area of one-half a blade, and a contour CDE may be sketched in by the eye in such way as to contain practically an equal area, and at the same time to have the general form of contour desired. The use of the rectangle is therefore purely as an aid in sketching in free hand the half contour in such way that the area may be closely realized and the contour determined in accordance with the taste of the designer. When satisfied on these points the curve may be smoothed out and taken as a trial contour. The accuracy of the area may now be tested, if desired, by running a planimeter about the contour and comparing with the desired amount. When thus adjusted to the satisfaction of the designer the contour is duplicated on the other side of the blade center line FC, and the entire contour is determined.

Instead of determining the contour of the blade in this manner by judgment, and with reference primarily to a rectangle as a starting point, it may be desired to develop an elliptical contour. To this end we may proceed as shown in Fig. 17. Let OC be the radius of the propeller as before. Then from A, the middle point of OC, describe the semi-circle CBO. Then lay in the hub contour as before, and divide the length of blade FC into any convenient number of parts and draw lines parallel to XY as shown. Then if distances PH_1, AB_1, LD_1, etc., are laid off as a fixed fraction of the corresponding ordinates of the semi-circle PH, AB, LD, etc., the points H_1, B_1, D_1, and others similarly determined will lie on an elliptical contour. Thus, if the fraction is .5, for example, we shall have $PH_1 = .5PH$, $AB_1 = .5AB$, $LD_1 = .5LD$, and similarly for all other like ordinates. In this manner, after determining the fraction which is to be used in any given case, the correct elliptical half contour may be readily determined, and then doubled on the other side of the axis *FC*. It only remains to give a rule for determining approximately the fraction to be used in any given case. The exact value will depend on the diameter of the hub; but for ordinary cases where the hub is about .20 the diameter of the propeller, the following rule may be employed:

Rule: Multiply the area of *one* blade by 5.66 and divide by the square of the diameter. The quotient will be the fraction suitable for fairly large size solid hubs. For small solid hubs the correct value will be slightly less, and for large hubs with detachable blades, its value will be slightly greater.

In any case the contour thus determined may be tested by planimeter and corrected as found necessary.

It should be understood, of course, that there is no especial virtue in the ellipse as a form for a propeller blade, and there is no reason for supposing that such a contour is better than any other generally similar form. It does, however, give a well formed blade, and has often been preferred by designers as a standard form, or in some cases as an initial form which may then be modified by taste or judgment as desired.

We now turn to item No. (2), the determination of pitch. It is seen from Fig. 1* that the pitch at any given small element will depend simply on the angle *APC*, which the plane of the element makes with the plane of rotation, and for a uniform pitch propeller this angle will be the same for all points at the same distance from the axis of the propeller, but will naturally vary with the distance from the axis. This angle for any particular radius is determined, furthermore, as shown in Figs. 3* and 18 at *QPR*, as the angle of a right triangle of which the sides about the right angle are, one *PQ* the circumference traced by the point *P* in a complete turn, and the other *QR* the pitch. If, therefore, we lay off a right angle triangle with these two sides about the right angle, then the angle opposite the pitch will be the pitch

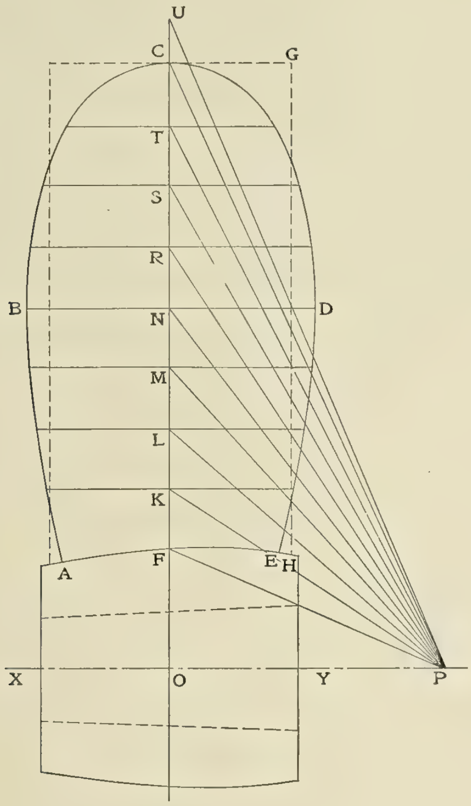


FIG. 16.

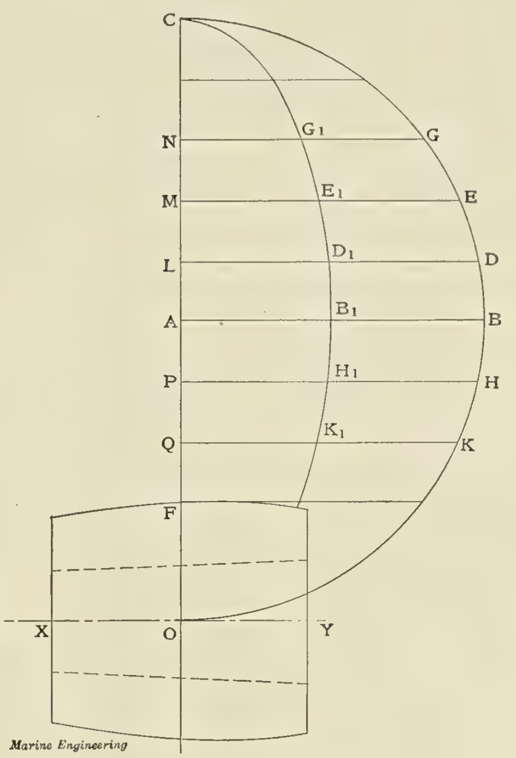


FIG. 17.

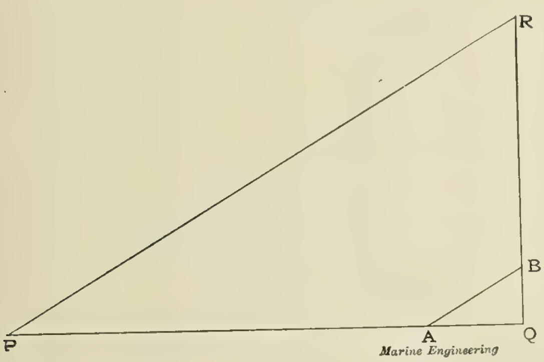


FIG. 18.

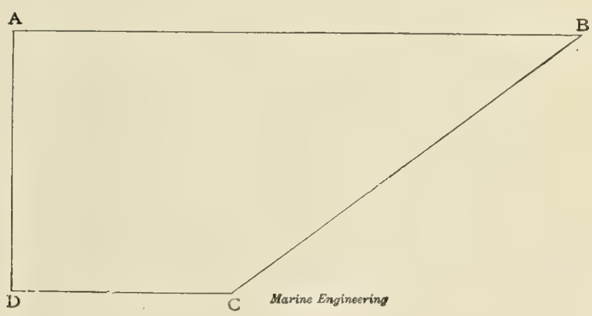


FIG. 19.

*See Marine Engineering, page 14, January, 1905.

angle desired. Now, if the pattern is to be made in wood, it may be desired to know this pitch angle at a considerable number of distances out from the shaft center, so that the slope of the blade may be correctly determined at a corresponding series of localities between hub and tip. This might therefore be done by determining such a triangle for each distance from the shaft axis. Suppose, however, we should divide both sides, PQ and RQ, by

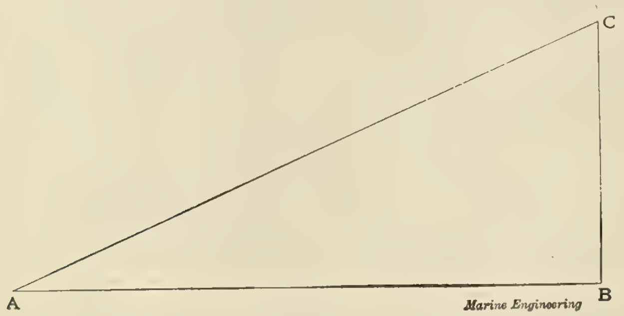


FIG. 20.

2π, or 6.2832; we should then have distances AQ and BQ reduced in this proportion, but determining the same angle $QAB = QPR$. Of these two sides it is seen that $AQ = PQ \div 2\pi =$ circumference $\div\ 2\pi =$ radius, while $BQ =$ pitch $\div\ 2\pi$. If, therefore, we should lay off a right angle with two sides, one the radius and the other the pitch $\div$ 6.2832, the angle opposite the latter side

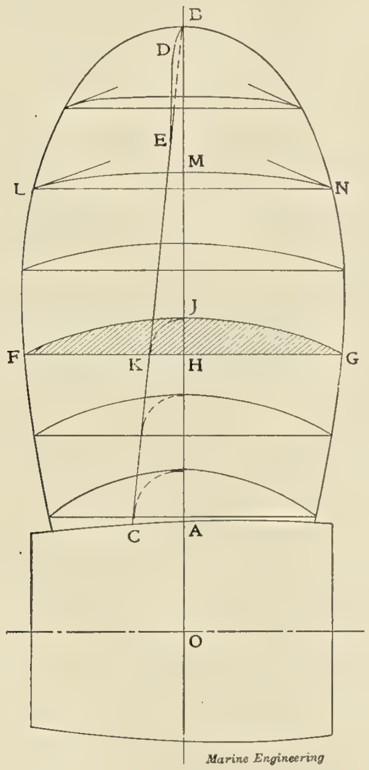


FIG. 21.

will be the pitch angle desired. This is actually carried out as follows:

In Fig. 16 lay off OP equal to pitch $\div$ 6.2832. Then from M, any point at which it is desired to determine the pitch angle, draw MP. Then the two sides of the triangle formed are MO and OP, and the angle PMO must therefore represent the pitch angle desired. If, then, a series of such lines be drawn to points F, K, L, M, etc., the lines PF, PK, PL, PM, etc., will give by their inclinations to the radius OC the values of the pitch angles at these various distances from the center line.

These angles are useful to the pattern maker for testing the slope across his pattern at any given distance from the center line. They may be employed in the following manner: Let a piece of sheet metal be cut in form as shown in Fig. 19, the angle at B being made equal to PSO, for example, in Fig. 16. Then suppose this strip of metal bent or rolled to a circular arc whose radius is OS. The strip thus bent will then form part of a cylinder of this radius, and a comparison of this with the construction of Fig. 2* will show that the line CB, Fig. 19, is similar to PR of Fig. 3, and therefore when rolled up to fit the form of the cylinder the edge CD will come exactly to the helix for this particular pitch and radius. Placed on edge, therefore, with CB downward and with DC resting on its circular arc of radius OS, the edge CB will serve as a test for the face of the pattern which, face upward, may be swung under CB and examined as to the closeness of fit. A series of such guides will thus serve to determine a series of lines across the blade, each of which will lie on the helicoidal surface which is to form the face of the blade. Such a series of lines or grooves across the pattern block being determined, the remaining material is readily brought down to a

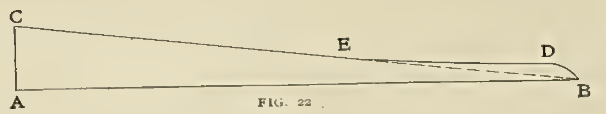


FIG. 22

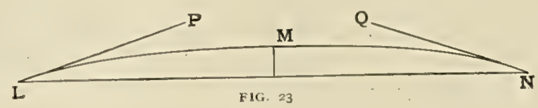


FIG. 23

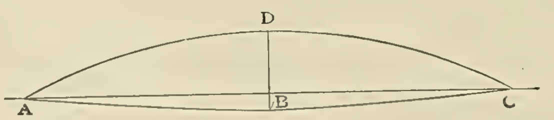


FIG. 24

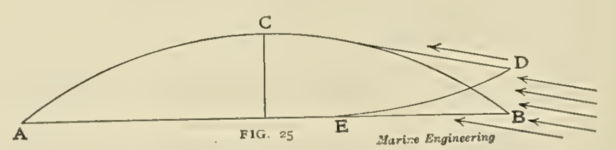


FIG. 25

smooth and continuous surface, giving a very close approach to the true helicoidal surface desired.

If, on the other hand, the blade is to be swept up in the foundry, there will be needed but one such guide, commonly known as a *guide iron*, and cut to the angle which would be given by a line drawn to some point (U, Fig. 1), lying just clear of the tip of the blade. In this case the guide iron is cut triangular in shape, as in Fig. 20, the angle BAC representing the inclination of PU to the radius, and therefore giving the pitch angle at this point on the surface supposed to be extended just beyond the tip of the blade. If next this guide iron is rolled into the arc of a circle of radius OU and stood on edge, it will serve as a guide to a horizontal sweep working on a vertical axis, and the edge of the sweep thus guided will by its movement generate the desired helicoidal surface, and the mold for the blades may thus be formed in the foundry and without the use of a pattern in wood.

We now turn to the last important feature which is to be shown on the drawing—the thickness and its distribution.

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*See Marine Engineering, page 14, January, 1905.

Rules for the determination of the thickness at the hub will be given at a later point. In Fig. 21 let AC be the midrib thickness at the hub, as thus determined by rule. Then draw a line CB. This would give a suitable midrib section from root to tip except that at the latter point it would become too thin for casting. To remedy this we modify the thickness at the tip as follows: At B lay off a curve BD with slope at B representing about the sharpest angle which can be readily cast with work of this character. Then run this curve into CB, with a reverse curve DE, and the section $ACEDB$ may then be taken as a suitable midrib section or thickness layout from root to tip of blade, giving by its width at any given point the mid thickness for the transverse section of the blade at this location. The construction of this midrib section is shown in larger scale in Fig. 22. Then to lay out the thickness section at any location as FG, the thickness HK is taken as radius and a quadrant KJ is swept over to the point J. Then a circular arc drawn through F, J and G will give for this location on the blade the form of section as shown.

For the thin sections toward the tip of the blade, this operation will require some modification. Here a circular arc passed through three points such as L, M and N would give edges altogether too sharp at L and N. To correct this we may draw through L and N lines LP and NQ, Fig. 23, making with LN the minimum angle which can be readily cast, and varying from 8 or 10 degrees for bronze to 20 or 30 degrees for cast iron. A curve may then be run in as shown, tangent to LP and QN at the ends, and parallel to LN, passing through M at the center. This will then give a suitable thickness section which will not be too thin at the edges.

In some cases a part of the thickness is put on the driving face, though this is a practice which can scarcely be recommended. This layout of thickness is sometimes adopted for sections near the root of detachable blades in order to give a better arrangement of bolt holes, but it is quite sure that such distribution of thickness will entail some loss of efficiency. In such case the total thickness, BD, Fig. 24, is divided as shown, and placed partly on the face and partly on the back, giving to the face a slightly rounded form.

Another modification sometimes met with, and which is presumably less objectionable or even probably beneficial, consists in modifying the sections on the leading edge near the root, as shown in Fig. 25. The section ABC shows the form which would result with the usual mode of procedure as already described. Where the sections are thick, however, it is quite likely that the flow of the water to the propeller may be in such direction as to encounter in part the back of the blade instead of the face. This would be the case for a relative motion of water and blade in the direction indicated by the arrows. In such case the back of the blade would be subjected to a direct force developed by this motion, giving a component directed aft and opposed to the movement of the boat. To avoid this result the sections may be modified as shown by $ACDE$, bringing the developed forces all on the face side of the blade, and with components forward instead of aft. In any event this modification of the section is only significant for the thicker parts of the blade near the root, and usually need not extend beyond from one-third to one-half the blade length from the root toward the tip.

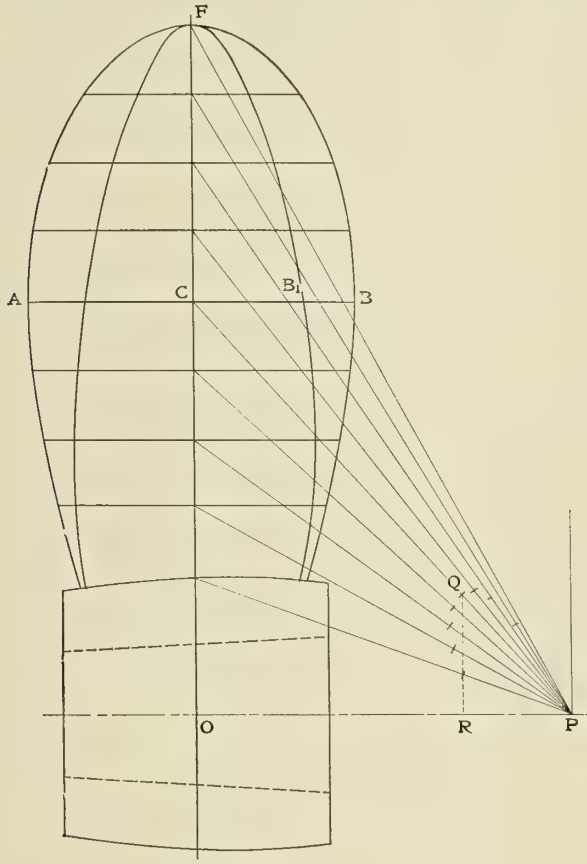


FIG. 26*a*.

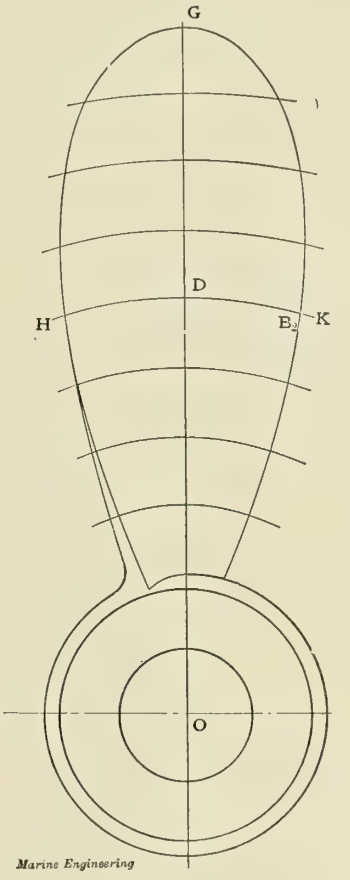


FIG. 27*a*.

Projected Form of Blades. We must next consider briefly the simplest method of obtaining an approximate projection of the blade contour on a plane either parallel to the axis or at right angles to it. It must be understood in advance that the methods in common use are not rigorously exact, as such methods would be very tedious in application. They are, however, quite sufficiently exact for all engineering purposes, and are employed practically rather than more complex methods.

In Fig. 26 (a) let the outer blade contour represent the actual or so-called developed blade form. Then we may conveniently split up the operation in question into a series of steps as follows:

(1) Lay down the end view of the hub as shown in (b) and draw a blade center line OG representing the line OF in (a).

(2) Lay off OP = pitch ÷ 6.2832, thus determining the point P.

(3) Let AB be any breadth across the blade. Then draw CP giving the angle PCO as the inclination of the element to the transverse plane, and CPO as the inclination to the longitudinal plane.

(4) Lay off $PQ = BC$ and draw QR as shown.

(5) Then PR is taken as the projection of CB on a longitudinal plane, and is laid off as CB_1 thus giving the point B_1 which is taken as the projection of B on a longitudinal plane.

(6) Next project C over to D and draw an indefinite arc HK.

(7) Then QR is taken as the length of a chord DB_2 thus determining a point B_2 which is taken as the projection of the point B on a transverse plane.

We have thus determined the two points, B_1 and B_2, taken as the projections of the point B of the developed contour, the former on a longitudinal and the latter on a transverse plane. In similar manner projections of other points are found, and thus the entire contour, point by point. With the developed contour symmetrical about OF as here assumed, the projected contours are likewise taken as symmetrical, one about OF and the other about OG, and the points found at B_1 and B_2 are then simply duplicated on the other side of the center line. Blades with unsymmetrical contours will be discussed at a later point.

By a further simple application of descriptive geometry we may show the end view of the blades, or of the surface which forms the driving face, but as this is rarely of practical value we shall not take the space required to describe the necessary operations.

The type of propeller thus far considered has been with uniform pitch, and blade contour symmetrical about a radial center line. We have next to note the chief varieties which may arise in the way of departures from this simple standard form.

Blades not symmetrical. In Fig. 27, let $ABCD$ represent a rectangle equal in area to the proposed blade, and determined as previously explained. Then supposing DC to be the forward edge, the designer may sketch in a contour $GHFKL$ approximately equal to it in area, but carried aft in such manner as shown in the figure. Such a contour may present somewhat the appearance of

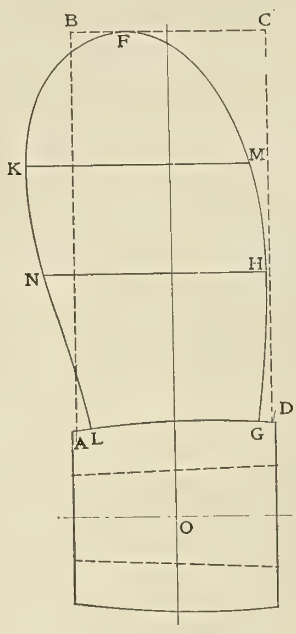


FIG. 27.

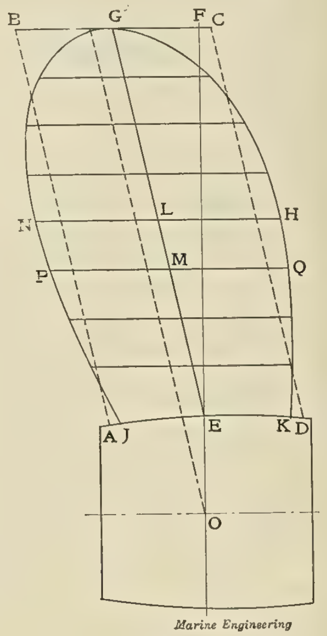


FIG. 28.

a blade bent back from the plane of rotation, as described in the preceding chapter, but quite different in the actual manner of its formation. This modification in blade contour is quite frequently met with, giving as it does, something approaching a

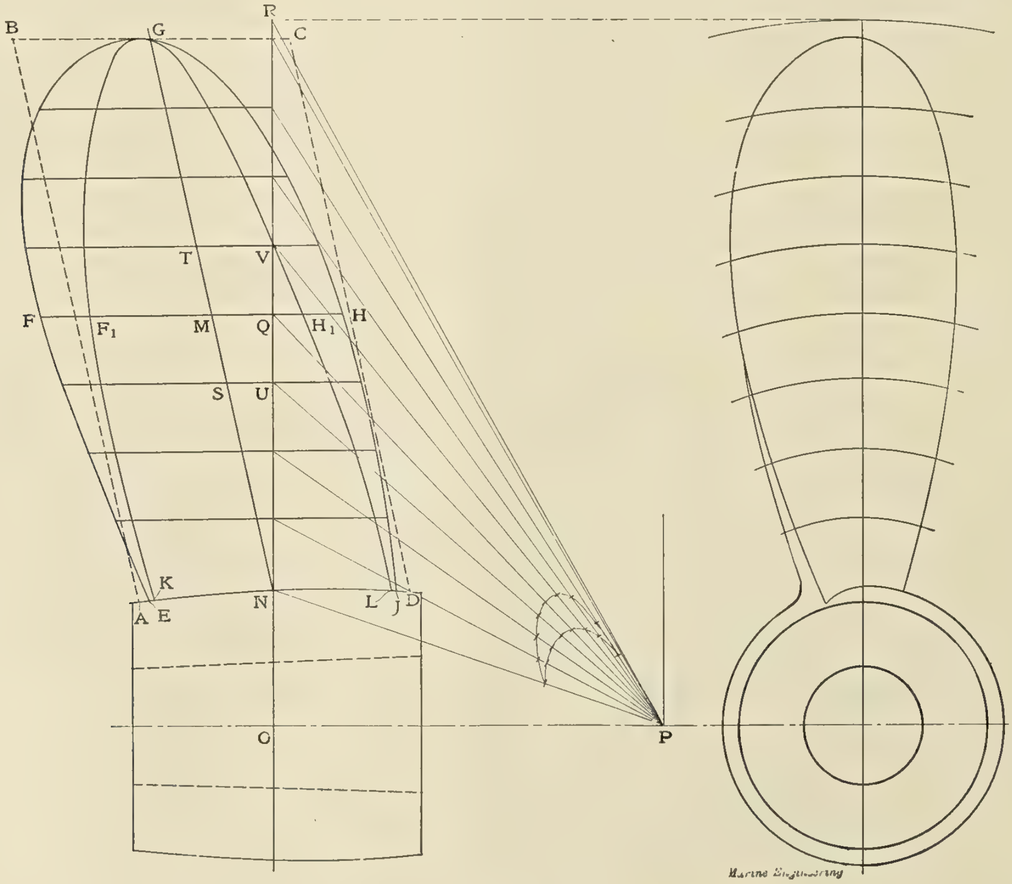


FIG. 29.

scimeter form for the leading edge of the blade as it cuts forward into the water. After thus sketching in the approximate form of blade it may be tested for area by planimeter, and corrected as may be needed to give the area specified. Whatever may be the form of contour ultimately accepted by the designer, its relation to a radial element, *OR*, will make it a simple matter to lay out such a contour on the pattern or swept mold, according to the method employed for making the propeller itself.

In order to obtain the projections of such a contour it is only necessary to treat each side of the center line separately, and in the same manner as previously described for symmetrical blades.

Blades bent aft. Let *EG*, Fig. 28, denote the line of the elements of the blade surface for this type of blade, as described in the preceding chapter, *FEG* denoting the angle by which the blade is tipped back from *EF*, the line at right angles to the shaft axis. To lay out the contour of the blade in such case we may proceed as follows: Let *GC* be determined as the half side of a rectangle of area equal to that of the proposed blade, and lay off *GB* and

In case it is desired to lay down a contour with unequal area on either side of the line of reference *EG*, it is simply sketched in by reference to the parallelogram in the same manner as described for the similar case with blades at right angles to the shaft axis, and as illustrated in Fig. 29.

In this general manner any form of blade may be readily specified and as readily laid down in the pattern shop or foundry.

In all such cases of blade form the main requirement is to determine the contour with reference to some line on the drawing, which line may be readily laid down on the pattern or mold. Then relative to this line the actual form is readily determined by transfer from the drawing.

The pitch angles for blade templates, guide irons, etc., for a blade tipped back as in Figs. 28 and 29, are not affected by the inclination of the blade in this manner, and are therefore the same for equal radial distances and the same pitch as for a blade at right angles with the shaft. They are therefore laid out as follows: In Fig. 29 let *M* be any point on the middle line *GN*, or *FH* any

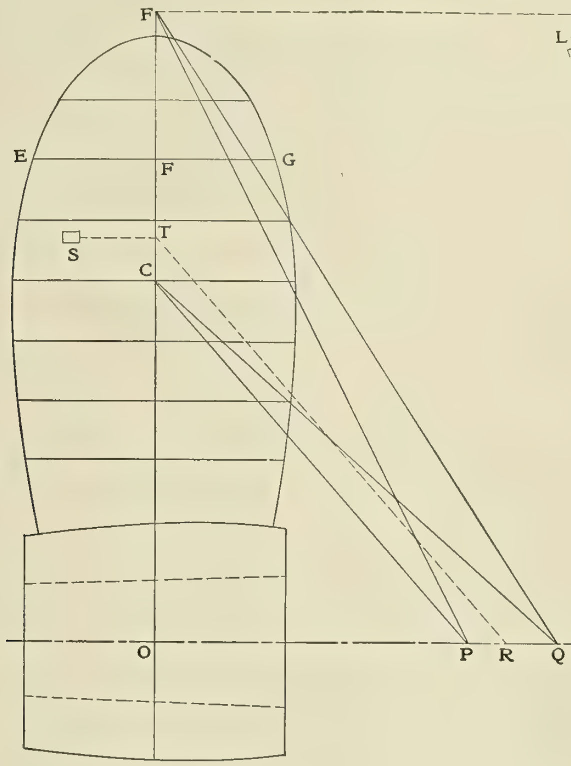


FIG. 30*a*.

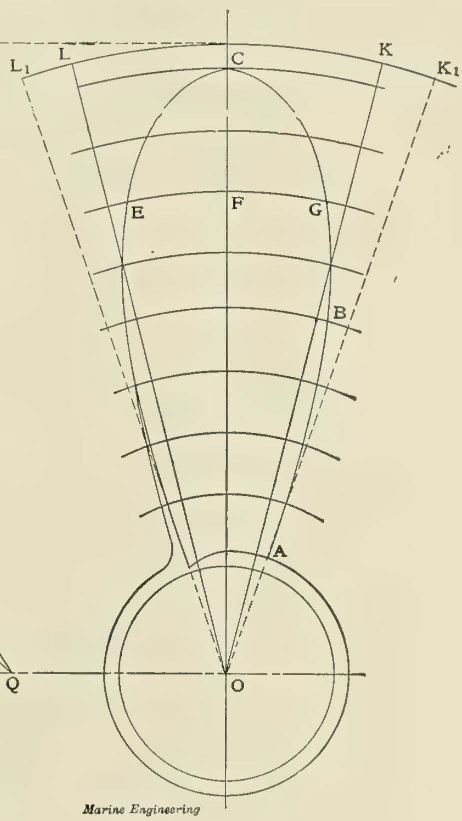


FIG. 30*b*.

GC as shown, completing the parallelogram *ABCD*. Then the area of this parallelogram will equal that of the blade desired. The designer may next sketch in by eye the half contour *GHK* as shown, making it as nearly as possible of equal area with the half parallelogram *EGCD*. This may then be tested by planimeter, and corrected as needed, in order to give the area specified. In all such cases where the use of a planimeter is suggested for the correction of the area of a contour determined as described, by reference to a rectangle or parallelogram, it may be remarked that the performance of a propeller varies only slightly for such minor changes in area, and no serious departure from the conditions of the design is likely to result if the first approximation as determined by eye is accepted without further correction.

When satisfied with the half contour *GHK*, the half breadths, *LH*, *MQ*, etc., may be duplicated on the other side of *EG*, giving the points *N*, *P*, etc., and thus determining the remaining half contour *GNPJ*.

A blade thus determined, as shown in Fig. 28, will have equal area on either side of the line *EF*, though it will not be symmetrical about this line in the usual sense of the term.

width across the blade for which the pitch angle is desired. Then we have simply to lay off $OP = p \div 6.2832$ as before, and draw *PQ*, making the right angle triangle *POQ*. The pitch angle for the element in question will then be *PQO*, the same as for a blade at right angles with the shaft and with the same pitch. Similarly for a guide iron at a radial distance *OR*, the angle will be *PRO*. In particular it should be noted, in the case of such blades, that the pitch angle lines are not to be drawn to points *S*, *M*, *T*, etc., on the blade center line, but rather to *U*, *Q*, *V*, etc., on the radial line at right angles through *O*.

The transverse and longitudinal projections of a blade thus bent aft are then found by the use of these pitch angles in the same manner as with blades at right angles with the shaft, and as illustrated in Fig. 29, similar to Fig. 26, for blades at right angles with the shaft.

Variable Pitch. We assume that the pitch is to be constant along any radial element of the blade, but varying from the leading to the following elements, with a value p_1 for the former and p_2 for the latter. Then, in Fig. 30, a lay-off, *OP*, equal to $p_1 \div 6.2832$ and *OQ* equal to $p_2 \div 6.2832$, thus giving two points, *P* and *Q*, for the two values of the pitch, instead of one, as in Figs. 26 and 29. Then for any radial distance *OC* the two angles *PCO* and *QCO* give the two pitch angles or angles of inclination for a small element located in the former case on the leading edge and in the latter on the following edge. Similarly for any other radial distance on the blade, while for a guide iron beyond the tips of the blade as at *F* the angles at the two extremes of the iron are given by *PFO* and *QFO*. In like manner the angles for any intermediate blade element with its intermediate value of the pitch may be found by laying off the corresponding intermediate point between *P* and *Q*, and drawing the inclined line from any point on *OF* at which the inclination of the element is desired.

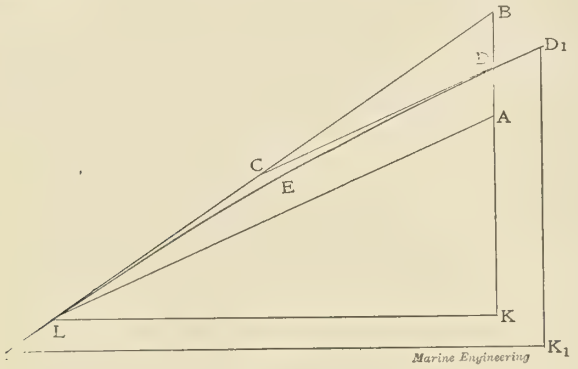


FIG. 31.

We must now consider the method of determining the projections of the developed surface in the case with variable pitch. As in other like problems dealing with the screw propeller, an approximate method will be given sufficiently accurate for practical purposes.

We have seen that the projection of a blade width depends on the pitch angle, while the latter varies from point to point across the blade with variable pitch. In order to simplify the problem, however, we may use an average value of the inclination, de-

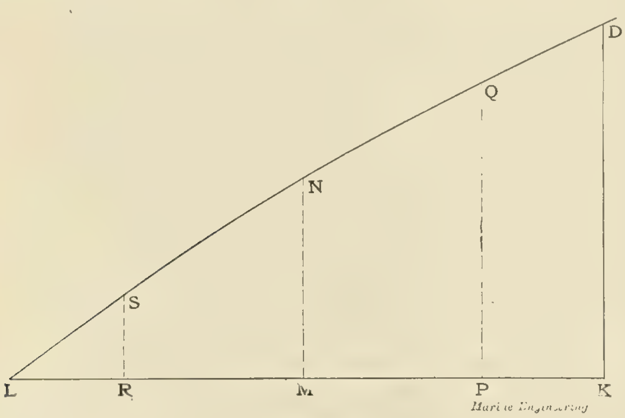


FIG. 32.

termined by drawing lines from a point *R* midway between *P* and *Q*, and proceed with the determination of the projected contour in the same manner as previously explained for uniform pitch. This gives, of course, only an approximation to the true form, but is usually sufficient for practical purposes, and if desired may be corrected by a method to be explained at a later point.

Let the projection on a transverse plane determined in this manner be represented in Fig. 30b with *ABC* as the leading edge. Then while it would be perfectly possible to give to the pitch along the curved edge *ABC* a constant value p_1, it is more simple in practice, as stated above, to select some radial line or element *OK* along which the pitch shall be p_1 and a similar line or element *OL* along which it shall be p_2. We may then proceed to develop a guide iron *LK* for such a blade in the following manner:

(1) Find the developed length of *LK*, *Fig.* 30*b*, and lay it off as shown in Fig. 31.

(2) Lay off two angles, *KLA* and *KLB*, equal respectively to *PFO* and *QFO*, Fig. 30*a*.

(3) Select by judgment a point *C*, and draw *CD* parallel to *LA*. The location of *C* should be such as to make $LC = CD$. It is readily seen that to this end the point *C* should lie slightly nearer *L* than *B*, and a point slightly on one side of the center of *LB* toward *L* will fulfill all requirements. A slight error in the location of this point will make no material difference with the form of the resulting guide iron.

(4) Draw a circular arc tangent to *LC* at *L*, and to *CD* at *D*, and extend beyond at each end somewhat, as shown at L_1 and D_1.

With this construction a guide iron, *LEDK*, cut out of plate and bent up as previously described, will serve to give a blade of regularly increasing pitch between the two radial elements *OK* and *OL*, Fig. 30*b*. If these elements do not contain between them the entire contour, as in the figure, then the guide iron may be extended as shown by L_1, *LE*, DD_1K_1. This will give the same law of pitch variation extended on either side of the elements *OK* and *OL*, and in this manner the surface of the entire blade may be swept up with the same general law of pitch variation. The radial lines OL_1 OK_1, Fig. 30*b*, give the extreme limits for the blade surface in this projection, and the arc L_1K_1 gives the

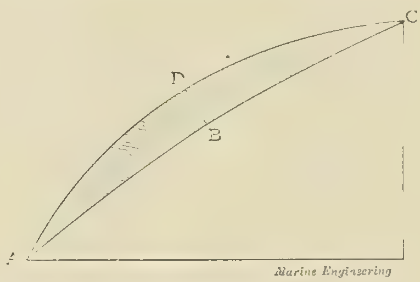


FIG. 33.

total extent of the guide iron for the entire blade. In Fig. 31 L_1K_1 must of course be made equal to this total length of arc.

Precisely the same general method of construction may be followed for the determination of a series of templates for testing the pattern across the blade face, in case it is desired to make the pattern in this manner, and as referred to at an earlier point in connection with blades of uniform pitch.

Referring now to Fig. 32, representing such a template, we may readily indicate the method of correcting the projections previously made, should such correction be desired. Assuming that *OC*, Fig. 30*b*, lies midway between *OL* and *OK*, find *M* the middle point of *LK*, Fig. 32, and erect *MN*, thus locating *N*. Now, suppose that *LKD* in this figure is the form of the guide or template for *EG*, Fig. 30*b*. Then find the actual or developed length of *FG* and lay it off at *MP*, Fig. 32, and erect *PQ*, thus fixing the point *Q*. Similarly determine *EF*, lay it off at *MR* and erect *RS*, thus fixing the point *S*. Then *NQ* and *NS* will be the actual or developed lengths of *FG* and *FE*, Fig. 30*b*, and these developed lengths may then be compared with the original lengths in Fig. 30*a*, from which *FG* and *FE*, Fig. 30*b*, were obtained by the approximate method first used. This comparison will readily show whether any correction is needed, and if so its character and general amount.

Template forms, as shown in Fig. 32, may also be of use in laying out the transverse thickness sections.

Thus in Fig. 33, let *ABC* be the template form for any given transverse section of the blade. Then in the same manner as illustrated in Fig. 21 the maximum thickness *BD* may be determined and laid off from *B*, thus giving the point *D*. A circular arc *ADC* may then be used for the back surface of the blade, or the general method of Fig. 23 may be used in case the circular arc would give at A and C edges too sharp for good casting. A series of such transverse blade sections may thus be laid down for the use of either the pattern maker or molder in determining the lay out of thickness over the entire blade surface.

There remains one type of blade to which brief reference may be made—that with pitch varying radially, or between root and tip of blade. The treatment of this case involves no new principles whatever, and may be readily worked out by the application of methods and principles already explained. Referring to Fig. 16 it will be remembered that the location of the point P will vary with different values of the pitch. If, then, this point is located for the various positions K, L, M, etc., along FC, as determined by the value of the pitch assigned to each position, and lines drawn from these points K, L, M, etc., each to its own location of P, the pitch angles will be thus determined, and the various items of the propeller may be laid out by methods of procedure entirely similar to those previously described.

These various constructions for pitch angle may be generalized as follows for any blade element with any specified pitch: In Fig. 30a let S denote any element whatever of the blade area, and of which the pitch is to have a specified value p. Then to find the pitch angle for this element lay off the distance $p \div 6.2832$, represented in the figure by OR, draw a line from S over to OC, the line at right angles to OR, and thus determine T. Then the line TP is the hypothenuse of the right triangle TOR, of which TO is the radius of the element in question and OR is pitch $\div$ 6.2832. The angle RTO is therefore the pitch angle desired. According as the pitch for the blade as a whole is uniform or variable, and if variable according to the law of variation, the application of this general method will result in the various special methods previously given.

In case the proposed propeller involves a combination of items representing departures from the simple standard type of Figs. 16 and 26, they may all be included in the treatment on the drawing board by an appropriate combination of the principles and methods explained with reference to each individual case. Thus while rarely met with we may have a propeller with the following characteristics:

(1) Blades bent back as in Fig. 28.

(2) Blades not symmetrical about any reference line, as in Figs. 27 and 29.

(3) Pitch variable axially as in Fig. 30.

(4) Pitch variable radially.

Such a case presents no difficulty whatever aside from the detailed work of carrying out the special construction which these various characteristics may require. If the fundamental methods and principles developed in connection with these various points individually are kept clearly in mind, there should be no difficulty in combining them in such manner as to care for a combination of such items in a single propeller.

In closing this chapter it should be remarked that there are some minor points of detail in connection with a propeller drawing for the use of either the pattern maker or molder which have been passed over, but which should not give trouble to any one who has clearly in hand the methods and principles discussed with reference to the main items of the work.

It should also be noted that for simplicity in the diagrams all special details of propellers with detachable blades have been omitted, in order to fix attention on the elements essential to the delineation of the propeller itself, and independent of such details as hub construction and fitting. It will be found that such omitted details relate solely to structural features, and that all problems relating to the delineation of a propeller as a combination of helicoidal blades joined to a specified form of hub may be solved by the application of the principles and methods given.

It should likewise be remembered that in all operative problems of this character, there are many ways in detail of accomplishing the same ends, especially when approximate methods are employed. Many variations in the above methods may therefore naturally suggest themselves to the thoughtful student, and many different methods for accomplishing the same result. The methods herein given have been tested in practice, are simple in use, sufficiently accurate in result for all practical engineering purposes, and involve only those items which are of actual significance for the pattern maker or molder. With such methods well in hand the draftsman should have no difficulty in giving to the pattern maker or molder the information most needed in order to produce the propeller itself, and in the form which will be most directly applicable to the special demands of the problem in hand.

FRENCH ARMORED CRUISER DUPLEIX.

French Armored Cruiser Dupleix.

Last summer there appeared in several North Atlantic ports a most striking warship flying the French flag. It was the new armored cruiser *Dupleix*, the flagship of Rear-Admiral Rivet, commander of the French Atlantic squadron. The peculiar appearance of this vessel to the eyes of one accustomed to American and British designs is shown in the engraving herewith presented. The *Dupleix,* which was launched at Rochefort in 1900, is one of a class of three ships, and may be considered a modern representative of a type of warships which the French designers have always regarded with favor.

By the courtesy of the *Navy League Journal* the following particulars of this ship are presented: Displacement, 7,700 tons; speed, 21 knots; normal coal supply, 800 tons; maximum bunker capacity, 1,200 tons, plus liquid fuel; armament, eight 6.4-inch and four 3.9-inch r. f. guns, ten 3-pounders, and six 1-pounders. The 6.4-inch guns are mounted in pairs in four turrets, two forward and aft and one on either beam, while the 3.9-inch weapons are mounted in broadside on the gun-deck. What seems to be a tactical disadvantage, and something quite at variance with former French practice, is the fact that the ship's sides have no tumble-home, and the broadside turrets are so placed that they cannot be trained parallel with the ship's axis, thus limiting the maximum concentration of fire dead ahead or dead astern to two 6.4-inch and two 3.9-inch guns. The 6.4-inch turrets are protected by 4 inches of armor, and are furnished with armored ammunition hoists extending down to the protective deck, which is of a uniform thickness of 2 3-4 inches, and is reinforced by a continuous water-line belt, which is approximately 5 inches thick amidships and 2 inches at the extremities. This is the limit of the *Dupleix's* armor protection, except for 6 inches of steel on the conning tower; her offensive powers are supplemented by two above-water torpedo tubes located one on either broadside forward of the beam.

A glance at the following table will show that she is far from being a match for the Italian-built *Kasuga,* of almost identical displacement, which was added to the Japanese navy just previous to the outbreak of hostilities in the far east.

Name of Ship.	Displacement, Tons.	Speed, Knots.	Bunker Capacity, Tons.	Armor.			Armament.	Total Weight. One Round from all Guns.	Torpedo Tubes, above Water.
				Belt.	Sides.	Turrets.			
Kasuga	7,400	20.2	1,100	6 in.	6 in.	5½ in.	Four 8-in.; fourteen 6-in.; ten 3-in.; four small guns;	2,520 lbs.	4
Dupleix	7,700	21	1,200 + liquid fuel.	5 in.	none.	4½ in.	Eight 6.4-in.; four 3.9-in.; ten 3-prs.; six 1-prs.	953 "	2

Obviously, for obtaining the maximum of efficiency from a given displacement, the palm lies with the Italians. In fact, the *Dupleix's* design is not likely to be repeated, even by the French, for it prohibits her coping with ships of her own class similar to those which took part in the engagement of the Korea straits, and limits her province in time of war to the running down and destruction of unarmored ships which lack the battery power to keep her at a distance. In time of peace, however, her generous dimensions—426 1-2 feet length by 58 1-2 feet beam, by 24 1-4 feet mean draft—coupled with the absence of a numerous battery of heavy broadside guns, make her a roomy, comfortable vessel, and one well adapted for use as a flagship.

THE STEAM TRAWLER SWAN.

THE NORTH SEA STEAM TRAWLER.

The steam trawlers in the North sea make up as sturdy a fleet of little vessels as ever encountered the severe gales of the great oceans. The condition of the North sea is enough to discourage the heart of the bravest sailor, as rough seas are the rule and not the exception.

The steam trawler is a vessel built specially for this service, and maintains her post on the fishing grounds for weeks at a time. The boats vary much in speed and size, but the average vessel used in the North Sea service is of about 100 net tons and 270 registered tons. The length of this boat between perpendiculars is 130 feet; beam, 24 feet; and the depth 12 feet 4 inches. Three hatches are fitted forward, 3 feet 6 inches square. The bulk of the trawlers are built near Hull, England, one firm turning out about 35 of these vessels a year, costing from $25,000 to $35,000. A few are built at Selby, a nearby town. The boats are of the raised-forecastle type with machinery located aft. The bows stand high out of water with considerable sheer, bringing the deck line amidships 3 or 4 feet above the water. A poop deck is generally fitted to protect the after gang ways and the engine hatches. On the low main-deck forward all the work of the fishermen is done; namely, emptying the contents of the trawl and sorting and cleaning the fish.

The English trawl differs from the American trawls in that it is a cone-shaped net dragged over the bottom of the sea; whereas the American trawl is simply a long line with hooks attached a little distance apart and used on sailing ships.

of course, the net follows last. When the net is out the after otter board is let overboard and the warp of this paid out; then the whole affair sinks to the bottom and drags along after the ship. The otter boards tend to spread the mouth of the net open.

STEAM TRAWLER LEAVING HULL.

Most of the recently built trawlers are fitted with the otter trawl, which is a decided improvement on the old beam trawl. It is a large net, shaped like a cone, with a large board fastened to each side of the oval mouth. These boards are about 6 feet high and 10 feet long, and are termed the "otter boards." On the net side of the board is bent the warp, and when the trawl is "shot" the foremost board is launched overboard first. So, when the vessel is steaming ahead, the otter board pays off, and, The size of the net is about 115 feet across the mouth and about 140 feet long. The trawl is allowed to remain down about four hours, the vessel meanwhile steaming along at full power. This renders the navigation of the vessel very difficult, as it is nearly anchored to the bottom with the weight and drag of the trawl. For this cause the trawlers have special lights so that other vessels can steer clear.

TRAWLERS UNDER REPAIR.

The several fleets of trawlers are under the direction of admirals, who order the vessels to take a certain course to avoid fouling any of the trawls. These directions are signalled by means of flares and colored rockets. Each vessel in a fleet has to carry the special lights ordered by the North Sea Convention and the Board of Trade. They are also bound to have their letter and number on the bows, quarters, and funnels of their ships, and are forbidden to conceal them. They all shoot trawls together at a given signal from the mark boat, the signal usually being a green rocket. The trawling is done in a depth of about 23 fathoms.

A fleet consists of 40 or 50 vessels, of which there are two classes, "single boaters" and "box trawlers." These differ only in occupation, the former fish more independently while the box trawlers fish in fleets.

The single boaters take in provisions, coal, and ice for about a week; they then proceed to the fishing ground and stay there until a sufficient quantity of fish has been caught, when they return home, unload, and start off again.

The box trawler fleet consists of 60 to 70 boats, of which 40 or more are on the fishing ground at one time. The individual boat leaves home coaled and provisioned for three or four weeks, and fishes with the fleet until it is necessary again to return home for food and fuel. No ice is carried by these vessels, but they deliver their fish cleaned and packed in boxes every twenty-four hours to vessels called the "carriers." The carriers pack the fish in ice and return to port to deliver the boxes on the landing stage at the fish market. As many as 1,500 boxes of fish are taken on board of these carriers every morning. The carriers also act as mail boats, and are seldom away from port over three days. When the fishing boat returns home she usually brings in a load of fish, but otherwise all the fish are taken by the carriers.

In conclusion it should be remarked that the crews of these boats are a set of very brave and hardy men, though a large percent of them are young. They are continually saving crews of shipwrecked vessels.

STEAMER KASHING.

The Victim of a Floating Mine at Wei-Hai-Wei.

The photograph shows the damage done to the steamer *Kashing* by striking a floating mine. The vessel, which was bound from Chifu to Shanghai, struck the mine at midnight on October 25, off the Shantung promontory, and had to put back to Wei-Hai-Wei. A large rent, measuring 10 feet by 12 feet, was torn in her port bow, and the deck above was blown up. One Chinaman of the crew was killed outright, another fell through the hole in the bow and was drowned, and three were injured.—*London Graphic.*

UNIFORM SPECIFICATIONS.*

BY W. D. FORBES.

Some time since a paper was read before this association on "The Interchangeability of Units for Sea Use." The idea was favorably received. The advantage of interchangeability of parts as well as units is certainly recognized as a furtherance of engineering work.

With these facts in mind, it is now proposed to carry the idea further and discuss the advantages of interchangeability of specifications.

It must be admitted that there is no sound reason why a steam engine, for instance, should not function equally well if ordered by one person or by another, provided running conditions are the same. It would seem that if a corporation could accept an engine complying merely with certain restrictions of weight, space and revolutions, without any regard to the material used, except that it be "first class," another could accept it without going into the detail of babbitt metal, steel, or composition entering into its make-up. It is self-evident that a firm constantly bending its attention to the manufacture of a high-grade machine will understand more thoroughly what is needed in its construction than an outsider.

It will, of course, be admitted that there are certain demands which must be met in special places, as, for instance, naval or merchant marine.

Some are liberal in permitting manufacturers to use well tried material not exactly meeting specifications, and some will pass engines which do not fill the requirements as laid down in specifications, but it is held that such procedure is manifestly wrong. The function of a specification is to specify; it should not demand information which is a trade secret or which cannot be imparted without practical demonstrations and experience, or something which prohibits obtaining the desired results, as for instance that "a hard sound casting for cylinder be furnished," and exacting that no scrap metal be used, and that the mixture of iron be clearly given. No foundryman would be willing to undertake to make a close, hard, iron cylinder without scrap, and few are willing to instruct others how to make castings, and very few, to tell the truth, are able to impart the knowledge.

Some buyers are very exacting about the babbitt metal, allowing only 2 percent of lead, while others make no demand as to this metal. A babbitt with but 2 percent of lead is good for certain positions, but is not good for high-speed work, and if pounding in is required, at least 20 percent of lead should be allowed. Pounding babbitt should be resorted to only to get a solid box; making hard spots in a babbitt bearing by pounding is self-evidently a bad plan.

A pig of babbitt is supplied, and a chemical analysis shows it to meet the specifications, bearings are poured of it, and it is supposed that the desired mixture is used, but this is not so, as a chemical analysis of the babbitt from the bearing will show that the original mixture does not exist, as much of the tin has gone up the chimney in melting. Here the buyer expresses a desire for a certain mixture, and then knowingly accepts something else.

Nickel steel is an article often demanded in engine specifications; its value cannot be questioned in many cases on account of its strength, but on small forgings there seems to be endless strains set up which no amount of annealing removes. Some articles seem impossible to make of this material when of small area, and retain their shape; whether ground or turned the springing seems to continue even when no forging is done. In nickel crank shafts of about 3 inches in diameter, great difficulty is encountered by the continual spring of the forging as the several cuts are taken, and very true cranks are hardly obtainable. That crank pins must line and be true cylinders, is a perquisite of an enduring engine, and as in small engines it is quite easy to

*Paper read at the twelfth annual meeting of the Society of Naval Architects and Marine Engineers, New York, November, 1904.

design a shaft which if made of but ordinary machinery steel will stand all possible strains and service, a party who does not demand nickel steel is getting by far the more reliable articles.

Many compositions demanded by the buyers are too hard, the formulæ 88-10-2 mixture is reported to be popular mainly because it is never furnished. It is a mixture which is very difficult to machine, and for high speed bearings is never employed in commercial work. In the bearings of a wood-working machine, where lasting qualities are of great moment, nothing but babbitt will be found with never less than 20 percent of lead in it. In fact it is held that the size of bearing has far more to do with its lasting qualities than the material of which it is made.

Probably the question of what is a right and what is a left-hand engine will be a continual source of argument with many, unless the turbine comes to the rescue; but one would suppose that this could be clearly settled by each engine builder. In one specification this is to be found: "When a person is standing at the commutator end and the direction of rotation is against the clock, the plant is right-handed." While this is incorrect, it is a clear description of what the parties choose to call a right-hand engine, and one which could be furnished without further question.

The wording in some specifications is hard to understand, as for instance the following: "The lower side of the combination bed plate to be planed perpendicularly to the line of the stroke of the engine." This might mean that the bed plate is to be set on edge in the planer and its bottom planed with a down feed—all it really means is that the bed plate is to be finished on its bottom.

As to what may be properly termed "first class" in material is open to debate, but certainly anything may be properly called so which has proved satisfactory in the past, and met the requirements of strength and endurance for a long period.

That weight, space, and lasting qualities are matters of great moment, especially aboard ship, is admitted, and it is, of course, necessary to have a clear statement of what is allowable, and to know the exact conditions under which a machine is to operate either afloat or ashore, before a design can be made or a bid given. It is sometimes claimed that a bond guarantee should be furnished by a manufacturer and he be left free to select all materials and designs, and some very successful buyers do thus order and accept articles, and it is hard to see why all should not adopt the same system; but failing this, why not adopt the other system of nominating everything and having some uniform chemical or physical tests which would pass all material, no matter where it goes or for whom it is ordered. Either condition would result in work being gotten out with less loss of time and at less expense, but one or the other system should be general.

If the latter system is decided upon, it could only be with the one desire that the very best is to be obtained; no other possible motive could be ascribed to its advocates; but it places the buyer in the position of nominating what should be used and then holding those who furnish it responsible, not a tenable position; while if the former system is adopted, the desire that the best be given is far more likely to result in success, as there is then no possible division of responsibility, and the experience of those most interested would be made available.

It would certainly seem that the bonded guarantee system would present to the navy allurements. The endless detail now imposed on officers as to material would be done away with. The experience of the navy is as free as air to us and all nations, and this, coupled to commercial experience and engineering ability, must result in manufacturers turning out mechanical contrivances which will fill all requirements, as their very existence would depend on so doing.

The necessary time now required for inspection in detail would be saved, and the time question will shortly become of far greater moment than it is now, in naval construction.

A writer in the *Army and Navy Gazette* attributes the satisfactory and remarkable freedom from breakdowns in the Japanese navy in the present war, to the "liberality" shown builders in designs and selections of material; but a large factor may be the absence of the enterprising newspaper reporter.

To conclude, it is held, first, that if there is a specification for an article it should be lived up to or the article be entirely rejected, and no responsibility should rest on the maker of an article except for good work, if accepted; second, if there is no specification the maker should be held responsible *by bonds* for the satisfactory working and lasting qualities of the articles; third, that one or the other method should be adopted.

ELECTRIC AND PNEUMATIC PORTABLE TOOLS IN SHIPBUILDING.

BY FRANK C. PERKINS.

Electric and pneumatic portable tools are largely used in modern shipyards, both in this country and in Europe, each type

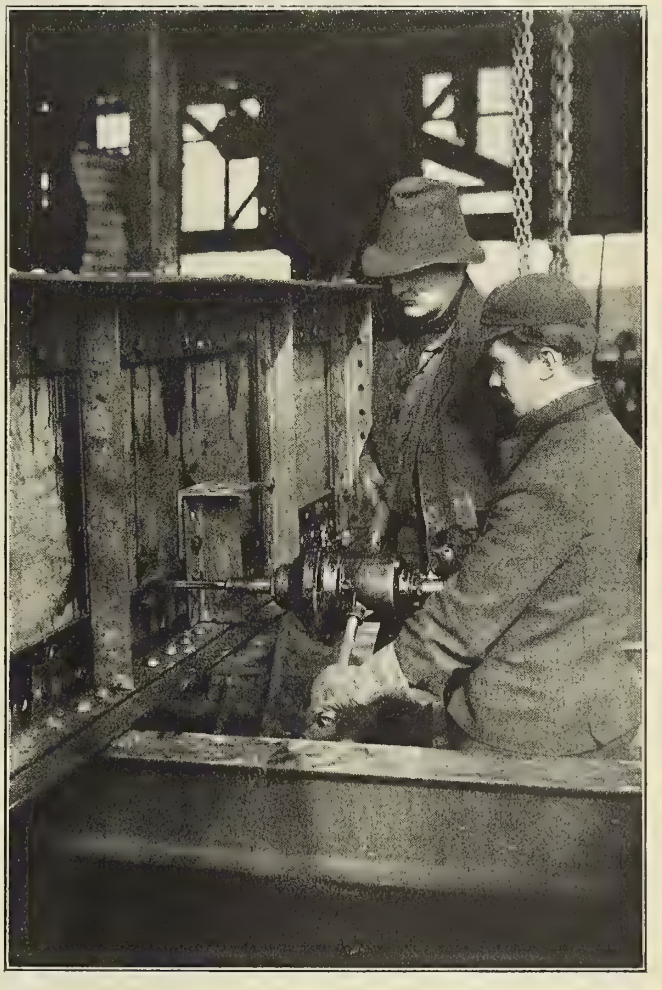


FIG. 3.—KELLER PNEUMATIC ROTARY DRILL AT WORK ON GIRDER.

having its own field of work to which it is best adapted. The accompanying illustration, Fig. 1, shows the operation of German electric hand drills at work on the plates of a steamship; while Fig. 2 shows an English electrically-operated portable drill, as constructed by Campbell & Isherwood, of Bootle, Liverpool, at work in a similar manner. While the pneumatic drill is largely employed, as shown in Fig. 3, the electric drill is fast supplanting it. Pneumatic tools which occupy a field exclusively their own, and with which electric tools can hardly be said to compete, are the pneumatic chipping tools and the riveter, both of which are in common use and well known. The method of operation and the auxiliary apparatus required in plate and girder structural work are well illustrated in Fig. 4, showing pneumatic riveters of the

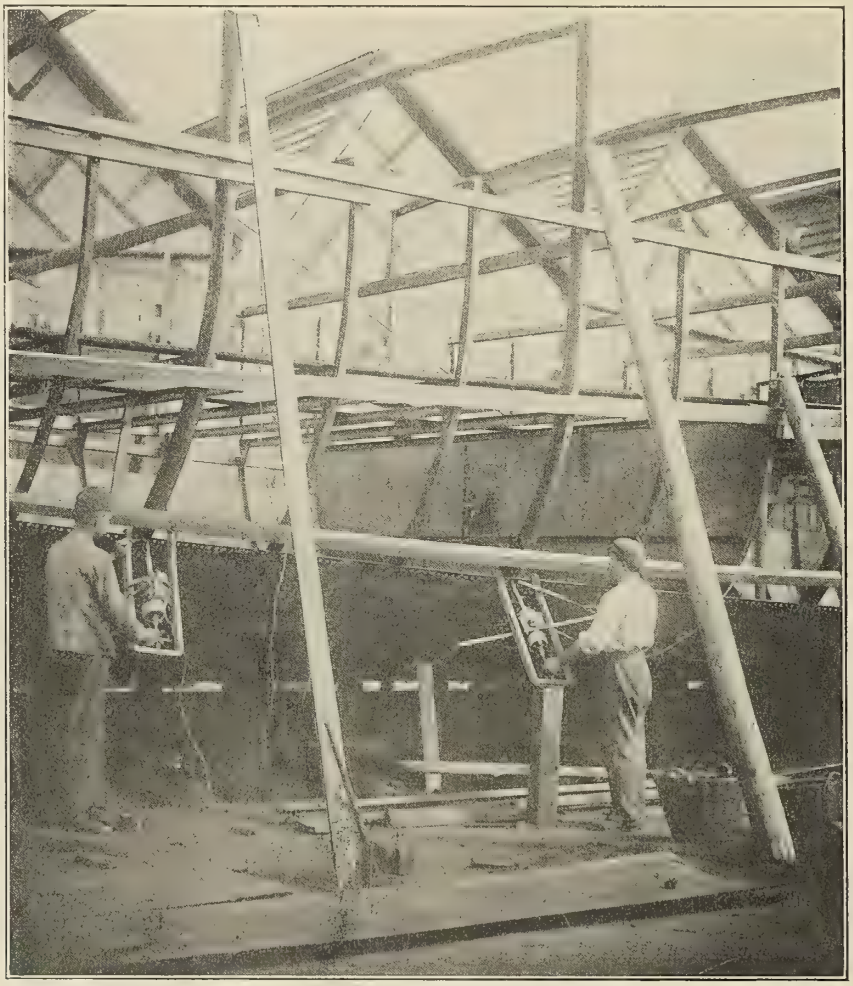


FIG. 1.—GERMAN PORTABLE ELECTRIC HAND DRILLS.

Cleveland Pneumatic Tool Company, in operation in Glasgow, Scotland.

The planing of the wooden decks of ships is one of the most laborious and unpleasant operations that fall to the lot of a ship's carpenter, and even the time-and-a-half rate allowed for this duty does not overcome the dislike for it. A large number of electric deck planers are now in operation in German and American shipyards, as well as in a number of the English shipyards on the Clyde and Tyne, which is an evidence of the alertness of the modern ship-building engineer to avail himself of the latest labor-

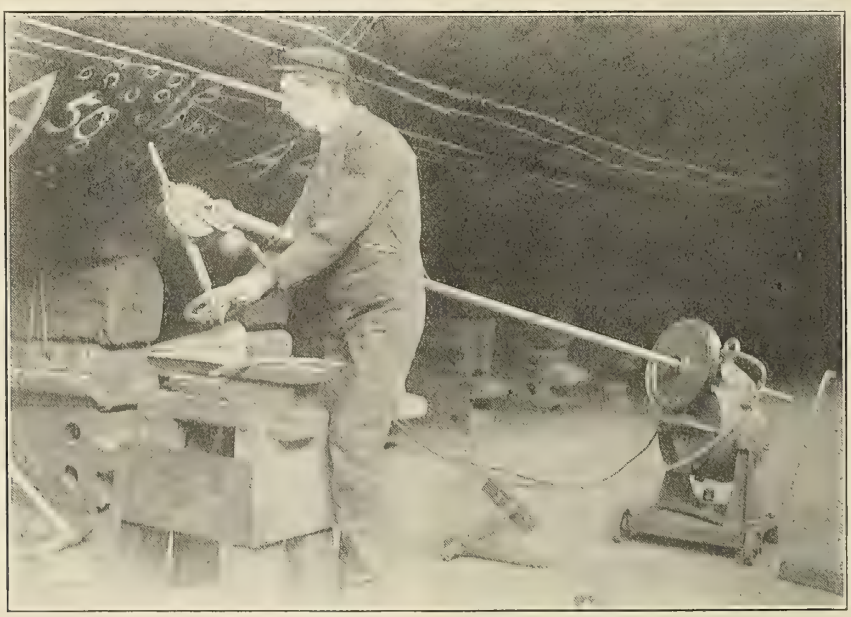


FIG. 2.—ENGLISH PORTABLE ELECTRIC DRILL.

saving devices. An electric deck planer constructed by Messrs. Mavor and Coulson, of Glasgow, is shown in the accompanying illustration, Fig. 5. Until recently these machines were fitted with direct-current motors only, but the introduction of three-phase current from supply stations has created a demand for deck

nearly the whole length of the long internal shaft. From the motor the motion is transmitted through the hollow shaft to the long sliding shaft, and this can be carried to the work to the limit of its length, or can be drawn back so that the drill head is very close to the motor.

FIG. 4.—CLEVELAND PNEUMATIC RIVETERS IN OPERATION AT GLASGOW, SCOTLAND.

planers fitted with alternating-current motors. The machine illustrated, which is equipped with a 3-horsepower motor running at 3,000 revolutions per minute, and driving the cutting knives at the same speed, will plane under working conditions on board ship an area of 360 square feet of deck in one hour. The attendance required is one man at 9 pence per hour to guide the machine, one apprentice at 1 1-2 pence per hour to draw it, and one apprentice at 1 1-2 pence per hour to sweep away the shavings, a total of one shilling per hour. By hand labor an area of 45 square feet of deck planed is a fair day's work for a carpenter, for which 10 shillings are paid. The machine therefore does in one hour, at the labor cost of one shilling, as much work as eight men do in a day, at a cost of four pounds, and the machine leaves a much better surface. On a vessel of moderate size the saving effected by the electric machine amounts to about £80.

The portable electric drilling machine of English construction, shown in Fig. 2, has no flexible or telescopic shafts, knuckle joints, or similar devices for transmitting the power from the motor to the drill, the drive being practically direct. The drill may be stopped or started instantly without removing the hand from the drill head, and the electric motor which is mounted on a truck, as well as the drill head and the whole portable tool, may be managed by one man without the slightest difficulty. The truck is two-wheeled, and so arranged that when the handles are released two short legs hold it in place on the ground or floor, as with a wheelbarrow, so that it cannot be moved about when in operation, as a four-wheeled truck might be. The motor rests on trunnions when in its carriage. A bracket carrying a hollow shaft is situated on top of the motor, and on one end of this shaft there is a spur wheel which is driven from a pinion on the armature shaft. A long internal shaft whose end is connected with the drill head slides inside the hollow shaft. On the inside of the hollow shaft there is a key which engages in a slot which runs

There are two pairs of bevel gear wheels, or four wheels in all, constituting the drill head, the hand wheel at the top being used to feed the drill spindle down when it is held in the clamp. The drill may, with this arrangement, be turned through a complete

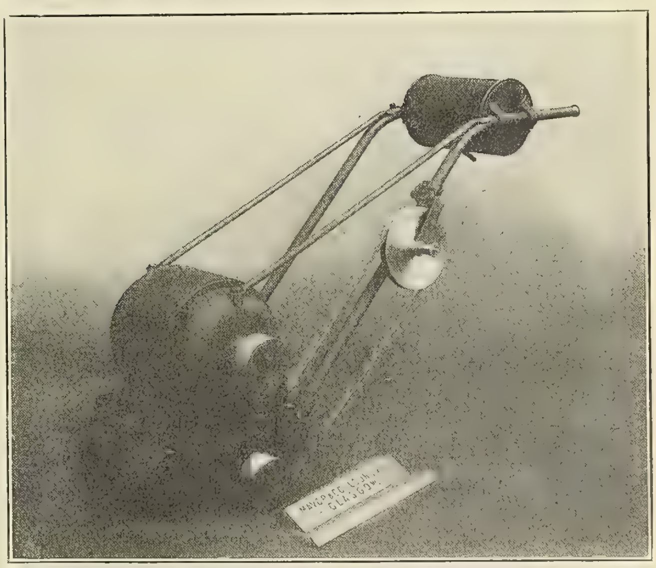


FIG. 5.—ENGLISH ELECTRIC DECK PLANER.

circle in the plane at right angles to the long shaft, also through almost a complete circle in the same plane as the shaft. When tapping has to be done and a slower and more positive motion is desired, a universal worm-gear drill head can be fitted to the outfit in place of the bevel gearing. This electric portable drill has a capacity for drilling holes in steel up to 1 1-2 inches in diameter, but larger machines are constructed to drill holes up to 2 1-2 or 3 inches in diameter, a 3-horsepower motor being required for the latter type, and a 1 1-2-horsepower motor for the smaller machine. The carriage weighs 138 pounds, the drill head 44 pounds, and the shaft 24 pounds, while the weight of the electric motor is 240 pounds. As the switch is placed near the drill head, the operator may start and stop the motor instantly when desired.

Flexible shafting is also extensively employed for transmitting power from portable electric motors to drill heads and other tools, particularly in America, while in Germany telescopic shafts are largely employed, with special portable tool heads designed for various classes of work in machine-shop practice.

"Engineers of America," a directory and biography, will shortly be published by E. C. Brown, editor of the *Progressive Age*, 280 Broadway, New York city. Mr. Brown states that he believes this work will fill a long-felt want, and he intends to supplement the personal data with a complete list of all the engineers associated with the various national engineering societies. Correspondence is desired with all practicing engineers, that the work may be as complete as possible.

SOME RECENT EXPERIMENTS AT THE U. S. MODEL BASIN.*

BY D. W. TAYLOR, NAVAL CONSTRUCTOR, U.S.N.

The experiments which are the subject of this paper have been under contemplation at the experimental model basin for some time, the design, construction, and testing of the necessary apparatus and appliances having necessarily extended over a considerable length of time. The experiments themselves are quite recent, the first regular test of a model propeller having been made in August last.

The primary object of the experiments was the determination of the power and efficiency of model propellers of the ordinary three-bladed type throughout the range of pitch ratio and blade area likely to be encountered in practice. In view, however, of the present tendency toward increasing speed of revolution of propellers, the experiments were extended to the unusually low pitch ratio of .4.

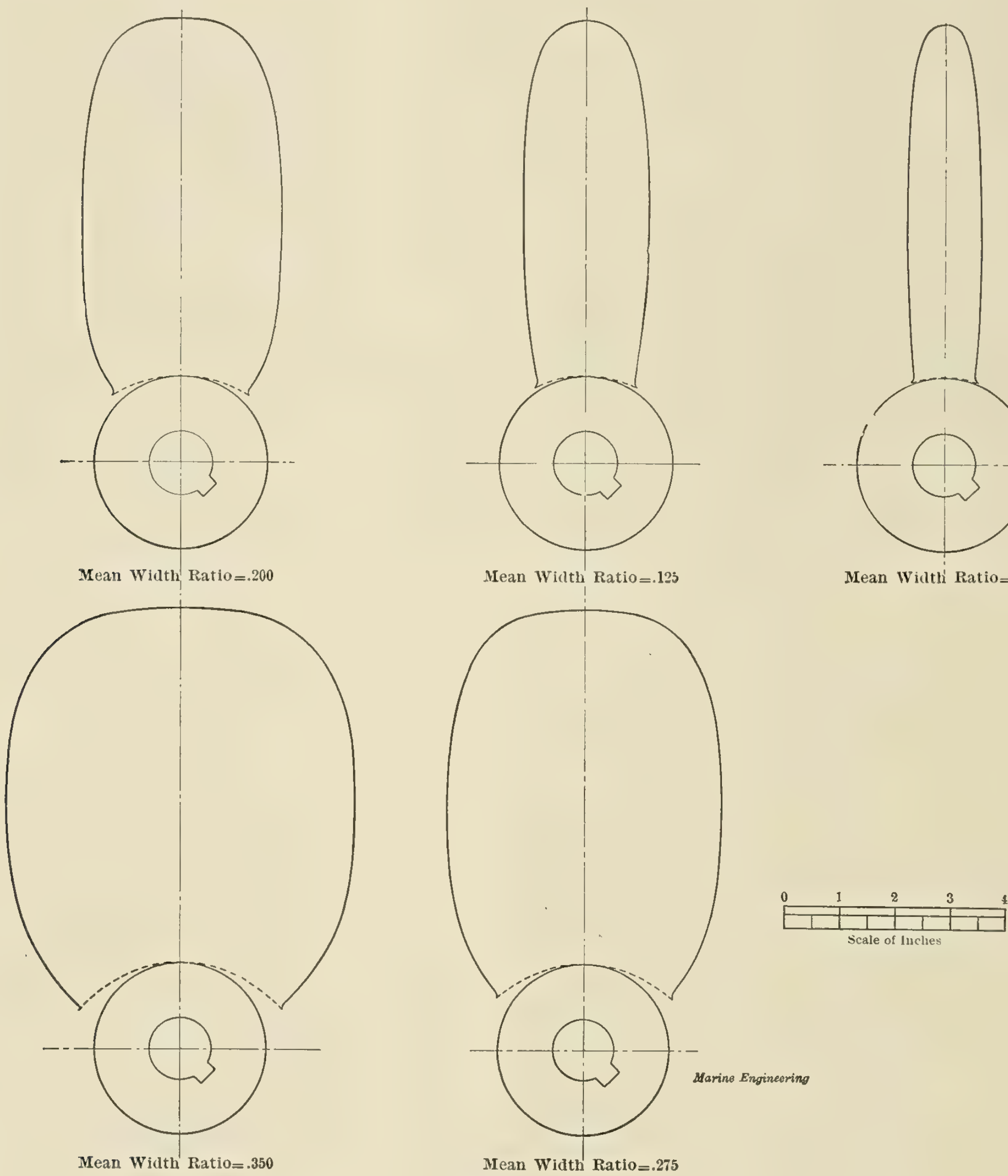


FIG. 1.

The series of experiments covered 30 model propellers. They were all 16 inches in diameter, three-bladed, of uniform pitch,

*Read at the meeting of the Society of Naval Architects and Marine Engineers, November, 1904.

diameter of hub 3 1-8 inches, thickness of center of blade at the root 9-32-inch, at the tip 3-32-inch. The pitches used were six in number, namely, 6.4, 9.6, 12.8, 16, 19.2, and 24 inches. For each pitch five widths of blade were used, the mean width ratios, actual total blade area and blade area expressed as a fraction of the disc area, being as indicated in the table below. Fig. 1 shows the blade area outlines used.

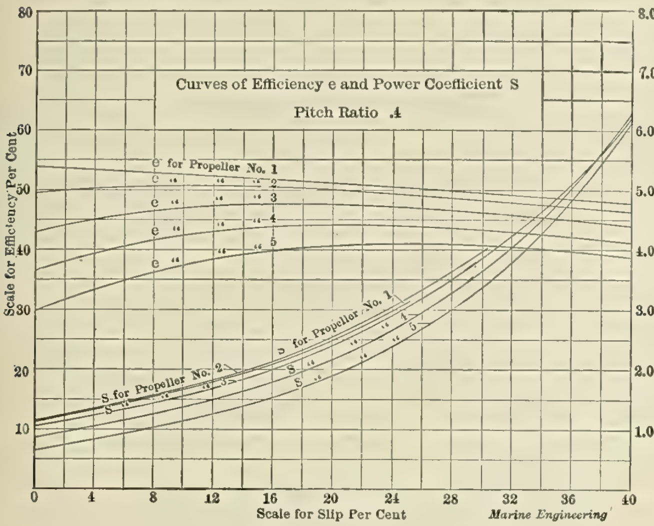


FIG. 2.

The propellers were of composition and were cast at first from wooden patterns, but afterwards it was found simpler to use plaster of Paris patterns. They were finished as to the face in a special machine described in Appendix "A."† The backs of the blades were finished by hand, and both backs and faces were carefully smoothed with emery cloth before the tests. The dynamometer apparatus and methods used for making tests are

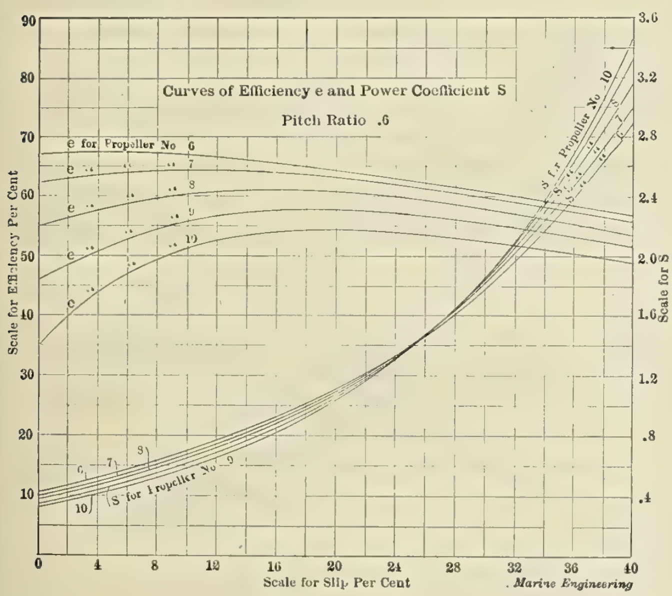


FIG. 3.

described in Appendix "B." The methods of reduction of the tests are described in Appendix "C." The results were carefully faired by cross-curves and propellers whose curves did not fair in satisfactorily were carefully retested.

I now invite your attention to the final results of the experiments. Figs. 2 to 7 show curves of efficiency and of a coefficient,

TABLE OF PROPELLER VARIABLES.

Propeller number.	Pitch Ratio. .4	.6	.8	1.0	1.2	1.5	Mean Width Ratio.	Total Developed Area Sq. Inches.	Developed Area ÷ Disc Area.
	1	6	11	16	21	26	.075	24.28	.1207
	2	7	12	17	22	27	.125	40.46	.2012
	3	8	13	18	23	28	.200	64.74	.3220
	4	9	14	19	24	29	.275	89.02	.4427
	5	10	15	20	25	30	.350	113.30	.5635

which I designate by S, conveniently called the power coefficient, for each of the thirty propellers. As explained in Appendix "C," if P denote the horsepower absorbed by the propeller, d the diameter of propeller in feet, and V the speed of advance of the propeller in knots, we have

$$P = .0093648\, S d^2 V^3.$$

Evidently then curves of e, or efficiency, and of S, completely characterize a given model propeller. The above formula will apply to a propeller of any size similar to the model propeller, provided the well known law of comparison connects the operations of the small and large propellers. We must look upon the

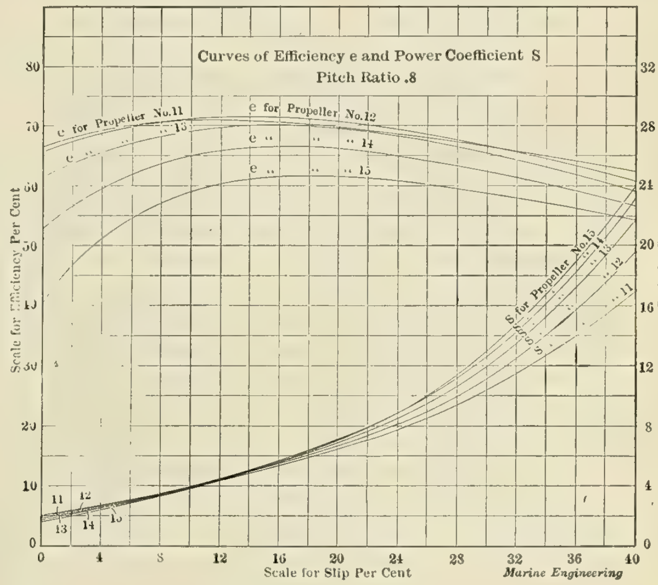


FIG. 4.

application of the law of comparison to propellers with some suspicion until it is practically demonstrated by comparison between model propeller experiments and full-sized propellers, but in the present condition of the science it is our most reliable guide.

The 16-inch propellers experimented with are materially larger than any previous model propellers concerning which I have knowledge. Froude's model propellers, experimented with about twenty years ago, were 8.16 inches in diameter. Prof. Durand's experiments, described in volume V of our Transactions (1897), were made with propellers 12 inches in diameter. A 16-inch propeller tested as these were is by no means a toy. Each propeller was tested up to a thrust of 150 pounds or a slip of 40 percent. The propellers of the coarser pitch did not show 150 pounds thrust with 40 percent slip, but they did show more than 100 pounds at the highest speed experimented with. The finer pitched propellers reached 150 pounds thrust at slips materially less than 40 percent for the higher speeds of advance.

After the runs the propellers were carefully tested on the machine described in Appendix "A" for variation of pitch. In no case was there any appreciable distortion of pitch. The five propellers of 1 pitch ratio were also tested for pitch in the machine with a weight of 50 pounds hung to each blade from its center at

†This and other appendices of the paper are not here published owing to lack of space.

a radius of 2-3 the maximum radius of the blade. Some of the narrow blades bent a good deal under this test, but did not change pitch appreciably at any point and took no permanent set.

In connection with Figs 2 to 7 it may be well to point out the fundamental elements affecting the powers and efficiencies of propellers. They are the diameter, the pitch, the blade area and

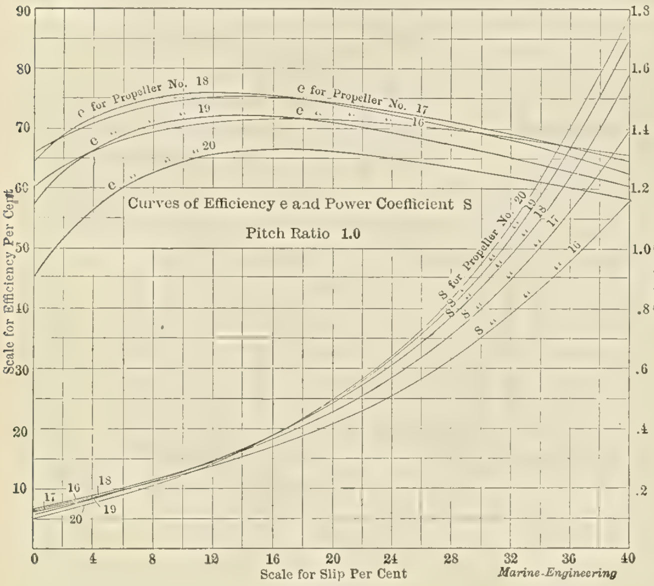


FIG. 5.

the shape of blade section. The latter is seldom referred to or included as a fundamental feature in propeller design, but these experiments indicate clearly that it is a thing which must be reckoned with, and that probably many unsolved puzzles in connection with propellers have been dependent upon shape of the blade section. The conventional meaning of the word "pitch," as applied to a propeller of uniform pitch, is the pitch of the driving face or helicoidal face. The back of the blade, however, also has a pitch at each point, and in the conventional section it varies from point to point. If the water always remains in contact with the back of the blade as well as the face of the blade, it would seem obvious that the pitch of the back of the blade necessarily affects the operation of the propeller. It is not generally realized how widely the pitch of the back of the blade varies from the

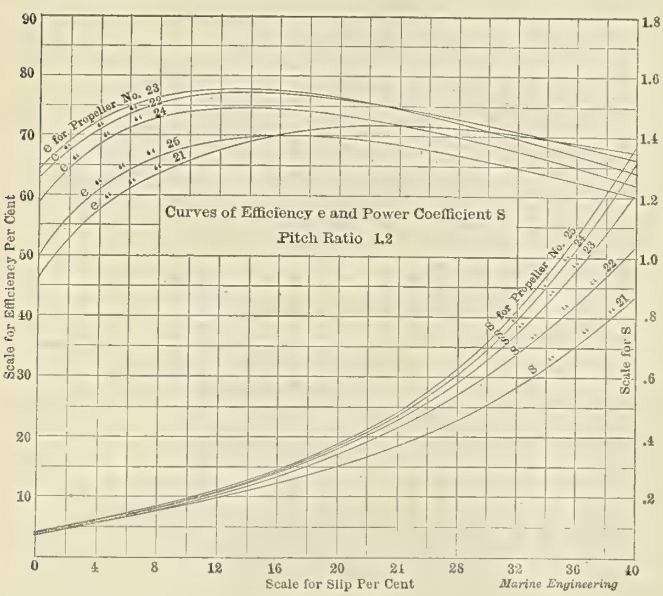


FIG. 6.

face. Fig. 8 shows for one series of the model propellers experimented with, namely, that which had a pitch ratio of unity, the variation of pitch of the back of the blade at a section taken at two-thirds of the radius from the center. For the finer pitch screws of the same section these variations are more pronounced; for the coarser pitches they are not so pronounced. It is seen that for propellers of .200 mean width ratio and a uniform pitch on the face of 16 inches, the pitch of the back varies from 7.8 inches to 26.4 inches. Conventionally we call the pitch of this propeller 16 inches, but it is obvious that it is practically impossible to know what the real pitch is.

While it is the primary object of this paper to lay before the Society actual results of comprehensive experiments which each member may analyze for himself, rather than to set forth theories of my own, I wish to direct attention to a few features of these results which appear worthy of remark and requiring explanation. In the first place we have been accustomed for many years to suppose that the maximum efficiency of the propeller varied but little from 70 percent. These experiments show a maximum efficiency of propeller No. 28 of 78.8 percent. While, as described in Appendix "B," the efficiencies do not take account of the hub action, and are hence slightly higher throughout than

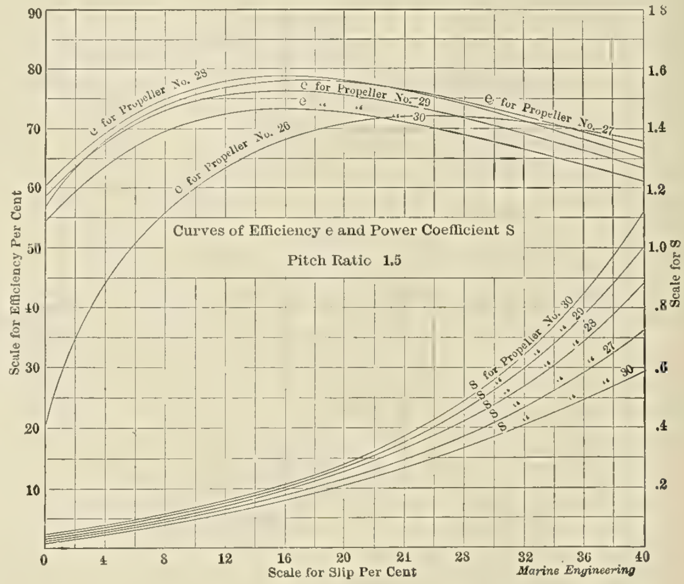


FIG. 7.

if the hub action had been considered, I am confident that the high efficiencies were actually obtained. It will be noted that these model propellers are most accurately finished and the blades are comparatively thin, the thickness at the root being .018 and at the tip .006 of the diameter. There is a steady falling off in efficiency as the pitch ratio is decreased. This was to be expected from theoretical considerations.

Perhaps the most remarkable feature of these results is the disclosure of the fact that as the pitch ratio is decreased the influence of the area of blade upon the results becomes progressively less until for the propellers of very fine pitch ratio the narrow blades actually absorb the greater power. For the propellers of .6 pitch ratio, curiously enough, at a slip of 26 percent it makes practically no difference what the width of blade is, the same power is absorbed by the propeller, although the narrow blades show somewhat greater efficiency. Below this slip the narrower blades absorb the greater power, just as for the .4 pitch ratio, while above this slip the wider blades take more power. As pitch ratio is increased this action becomes less and less, until for the higher pitch ratios experimented with the power absorbed is greater the wider the blade. The increase in the power with increasing width of blade is, even for the high pitches, however, much less than it should be according to propeller theories of which I have any knowledge. Fig. 9 shows for 25 percent slip for the series of 1.5 pitch ratio a curve of power absorbed plotted over mean width ratio.

Another remarkable feature is the fact that as the pitch ratios of the propeller decrease, the power absorbed and efficiency at low slips are both very great, the slip being based upon a conventional pitch.

ratio were tested up to 6 knots only. Fig. 10 shows curves of thrust and torque plotted upon slip for propeller No. 1 for 5, 6 and 7 knots speed of advance. The 5-knot curves are normal. The 6-knot curves show evidences of cavitation at about 0 percent slip and 115 pounds thrust. The 7-knot curves show strong evidences of cavitation at about—15 percent slip and 80 pounds thrust.

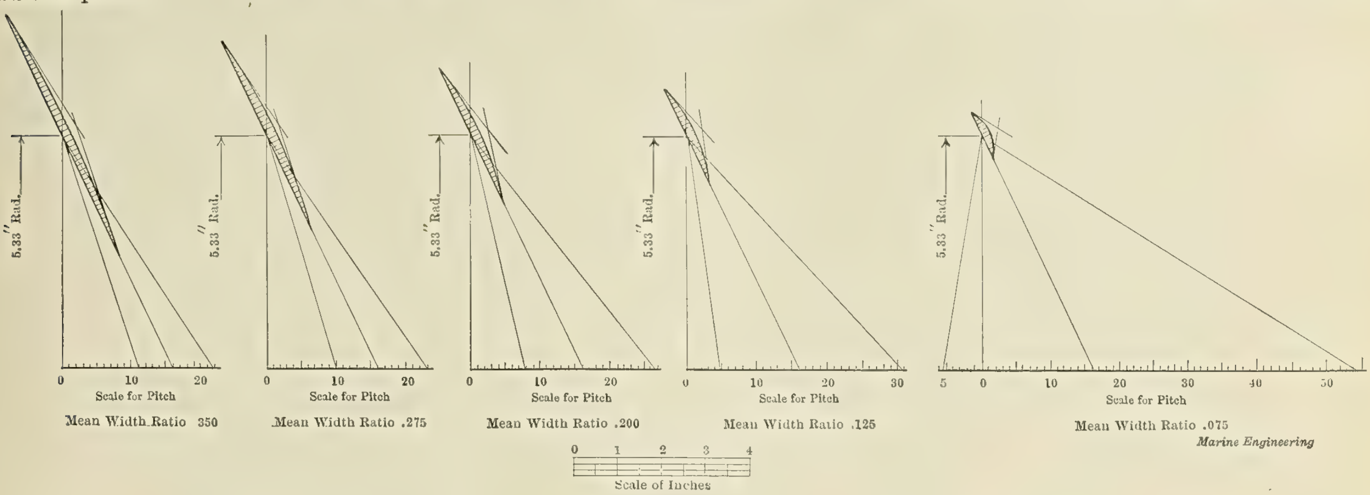


FIG. 8.

Thus considering the series of propellers from Nos. 6 to 10 it is seen that for the narrowest blade the efficiency at zero slip is 66.8 percent while the maximum efficiency of this propeller is but 67.4 percent. As the blade width is increased this effect is decreased. Of course an explanation of many of the features above described is the fact already pointed out that the slip based upon conventional pitch is necessarily erroneous. It would seem that the real or effective pitch of the propeller was a quantity which varied very much. For small slips the effective pitch would seem to be very much greater than the nominal pitch, whereas for large slips it would seem to become less again. In other words, at small slips the propeller acts as if the following portion of the

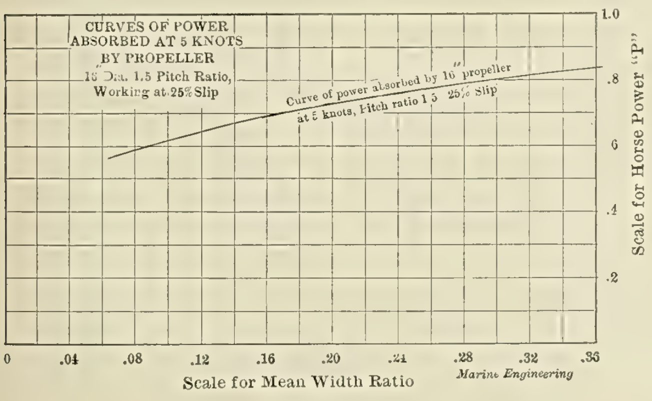


FIG. 9.

back of the blade was predominant, whereas at large slips it acts as if the leading portion of the back of the blade assumes predominance.

CAVITATION.

It is generally recognized that model propeller experiments are of little value as regards cavitation, owing to the fact that model propellers working under the combined pressure of the air and water have a virtual submergence very much greater than that of full-sized propellers. For many of the propellers experimented with there seemed to be a tendency toward reduction of thrust and torque when tested at the 7-knot speed, but there was no pronounced cavitation observed, except in the case of No. 1 propeller when tested at 7 knots. Most of the propellers of this pitch

It will be noted that cavitation occurred at a very low thrust per square inch of projected area, about 4.3 pounds for the 7-knot speed, and that the thrust at which cavitation became marked was about 40 percent greater at 6 knots than at 7 knots. I feel very confident that in the case of this particular propeller the breaking down, which we call cavitation, while affected by the thrust, was

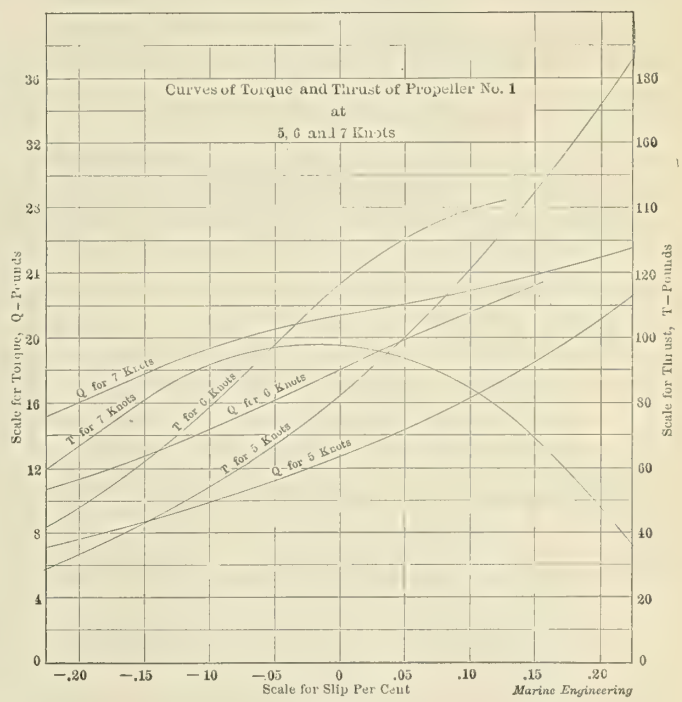


FIG. 10.

strongly affected by two other factors, namely, the speed of revolution and the shape of the blade section. In other words, in this particular case the breaking down of the propeller was a case of cleaving the water, as when one draws a stick through water, and at a sufficiently high speed of revolution the propeller would have shown cavitation with almost no thrust. It seems reasonable to suppose that all cavitation is largely of the same nature, and a function not only of the thrust but of the speed of revolution and shape of blade section, and that it could probably be mitigated in many cases, or deferred by modifying suitably the blade section.

As bearing upon the effect of shape of blade section, I submit Figs. 11 and 12. These refer to three propellers, Nos. 23, *23a*, and *23b*. No. 23 was one of the regular series, 16 inches diameter, blade was the same, namely, 19.2 inches. Fig. 12 shows together the curves of efficiency and S for these three propellers. It is seen that for propeller *23a* there is a slight gain of efficiency as compared with No. 23, the usual shape, but a marked falling off in the power utilized. At the slip corresponding to maximum ef-

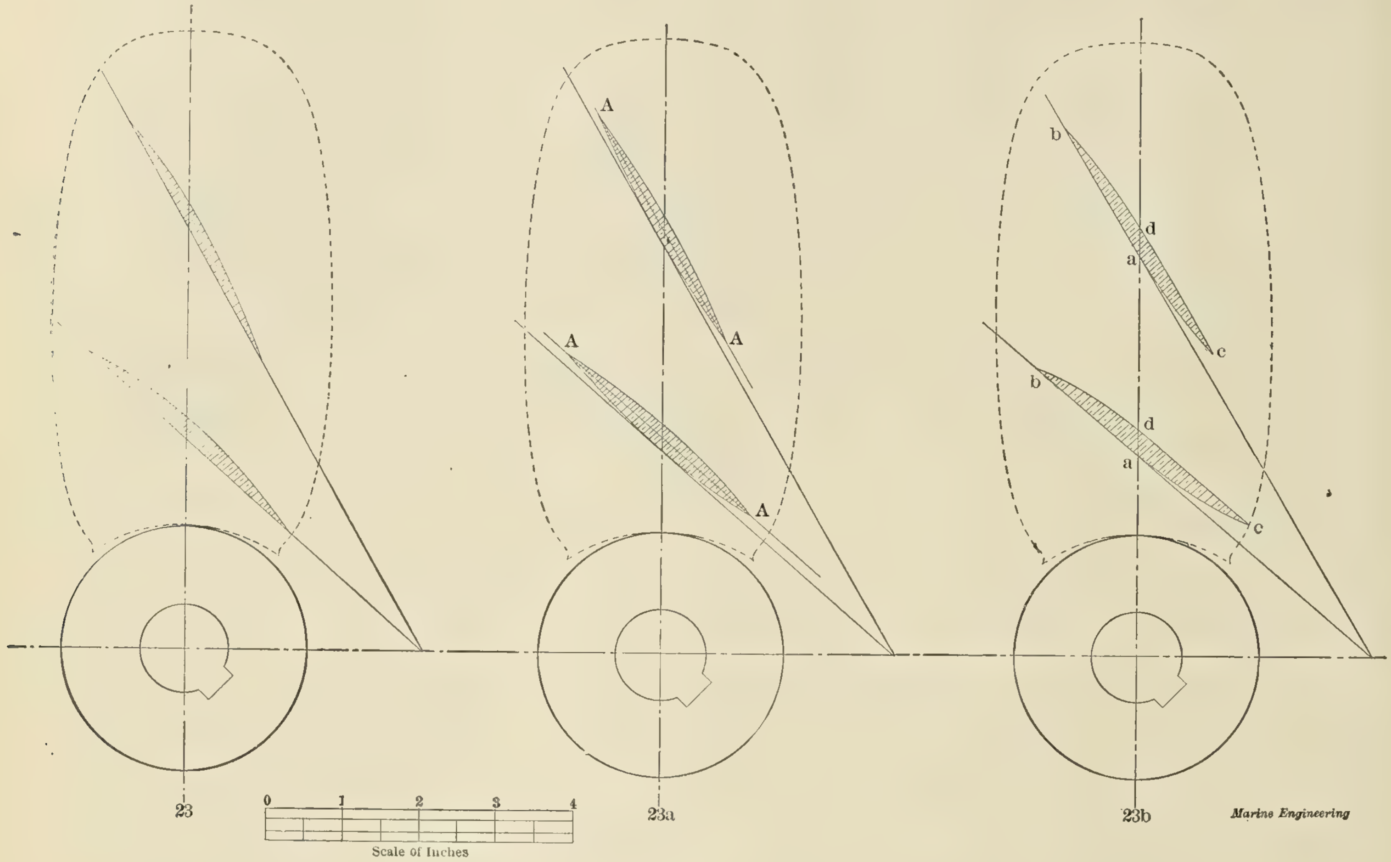


FIG. 11.

19.2 inches pitch, 64.7 square-inch blade, and .200 mean width ratio. Nos. *23a* and *23b* had the same diameter and blade area, but had sections as shown in Fig. 11. The pitch of the lines AA

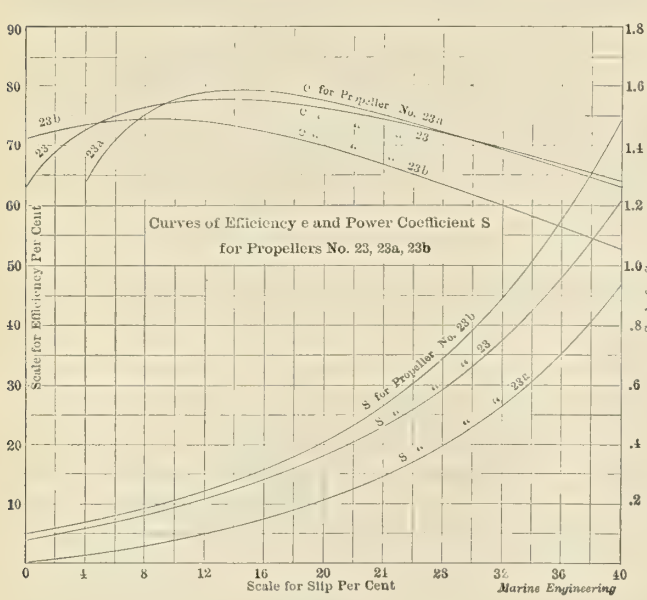


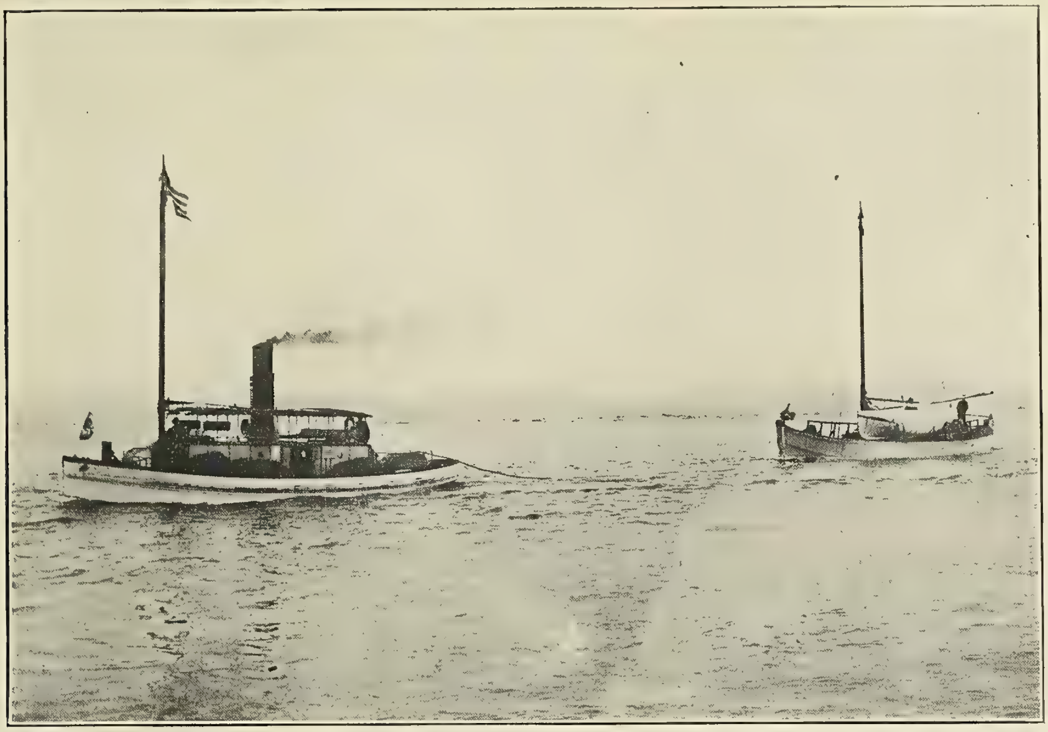
FIG. 12.

for *23a* was 19.2 inches. In other words, the face and back of the blade were similarly convex. For *23b* the pitch of the portion *a-b* of the face of the blades and the portion *c-d* of the back of the ficiency *23a* can utilize only about 50 percent as much power as No. 23. Propeller *23b* shows a falling off in efficiency as compared with 23 and *23a*, except at very low slips, but has somewhat more capacity for utilizing power than No. 23. Propeller No. 23 was also run reversed, with the backs of the blades driving. The results are not shown on the curves, but the maximum efficiency shown was not as great as 50 percent.

Fig. 12 illustrates strongly what is evident from careful examination of Figs. 2 to 7, namely, that the shape of blade section is a very important factor in propeller performance. It should be noted in this connection that fine pitched propellers should have as high a value of S as practicable in order to keep down the diameter and increase the pitch ratio.

While a number of the model basin staff have taken part in the propeller experimental work, the reduction of the experimental results has been done almost entirely by or under the direction of Mr. A. V. Curtis and Mr. L. F. Hewins. These gentlemen have given me much valuable assistance in preparing the appendices to this paper, and without their assistance it would have been almost impossible for me to have prepared it in time for the meeting of the Society.

The steamer *Eastland*, mention of the high speed of which was made on page 42 of our January issue, has been fitted with the Ellis & Eaves system of induced draft. We are informed that prior to the installation of this system the boat was able to make only about 18 miles per hour, and it was not until after this system was in operation that the designed speed of 21 miles was reached.



THE TUG CHAMPERICO.

Tug Boat Champerico.

The accompanying engraving was taken of the wooden tug *Champerico,* as she started on her long voyage from San Francisco to Champerico, Central America, which is to be her home port. She was built by John Twigg and Sons' Company, the well-known ship and boat builders of San Francisco. The hull is constructed of pine, while the frames, stem, stern post, keel, and rudder are of oak. The general dimensions of hull are as follows: length over all 55 feet; molded beam 14 feet; depth of hold 8 feet, with a draft of 6 feet 6 inches loaded. She is strongly constructed throughout to meet the requirements of a boat of her class, which is subjected to severe usage in the handling of lighters and barges used for loading and unloading vessels in Central American ports.

The engine is of the fore-and-aft compound type, with cylinders of the following dimensions: high-pressure cylinder, 10 inches diameter; low-pressure cylinder, 22 inches diameter, with a common stroke of 14 inches. The air, circulating, bilge, and feed pumps are driven from the low-pressure crosshead by means of a beam. They were formerly used in the tug *Adolpha,* which was wrecked in Central America about one year ago, and are of the best workmanship and in first-class condition. Steam is supplied by one Scotch boiler, of the marine type, 90 inches diameter by 120 inches in length, with a working pressure of 160 pounds per square inch. An average speed of 9 miles an hour was maintained during the trial trip, which was of 4 hours' duration. As shown in the engraving she has in tow a 45-foot lighter loaded with 30 tons of coal, with which, with 12 tons in her own bunkers, and a deck load of 8 tons more, she will make the trip of about 2,400 miles without calling at any port *en route* for fuel.

Captain North, of New York, with four men, make up the little crew that has undertaken the task to deliver her to her owners. Mariners are somewhat skeptical as to the safety of making such a long ocean voyage in a vessel of the *Champerico's* dimensions, but it has been successfully done several times before in vessels of even smaller size built by the same builders. Captain North states that he expects to make an average speed of 7 1-2 miles per hour during the trip if he meets with moderate weather and has no serious mishaps.

An Alternate Bid on the Armored Cruisers.

Mr. Francis T. Bowles, president of the Fore River Shipbuilding Company, and formerly chief constructor of the United States navy, submitted an alternate and most interesting bid for the construction of the two armored cruisers *North Carolina* and *Montana,* for which contracts were recently let to the Newport News Shipbuilding and Dry Dock Company. His bid was as follows:

"This letter is submitted in explanation and description of our bid of this date on an armored cruiser, or cruisers, of 14,500 tons displacement each, and is accompanied by a set of plans numbered from 1 to 11, inclusive, showing the modifications in the department's plan upon which this bid is based. This bid is offered under the terms of the act appropriating for these vessels and with particular reference to the following words: 'And the contract for the construction of these vessels shall be awarded by the Secretary of the Navy to the lowest responsible bidder, having in view the best results.'

"Believing, in 1902, when the designs for the armored cruisers *Tennessee* and *Washington* were prepared, that these vessels were not only the most effective of their class designed up to that date, but that they also met with care and sufficiency such criticisms as had been made by officers of the navy upon vessels previously built and designed, with special reference to the isolation and the operating of the elements of the battery, the safe and rapid supply of ammunition, and armor protection, it is also apparent that since the date of these designs and due to the experience of other countries with large armored cruisers, a legitimate criticism upon these designs has been made that a considerable portion of the battery is located too near the water line for effective use at sea. Therefore, with a view of overcoming this objection, and also with a view of obtaining a further and better protection for the vitals of the vessel by armor, a better isolation and efficiency of the battery and a greater end-on fire, we have prepared and submit these designs, believing that the fighting value of the vessel will be greatly enhanced.

"We have also arranged to present to the department in this design the Curtis marine turbine, an American invention already highly developed for stationary use, in place of triple-expansion reciprocating engines. There will be one low-speed reversible turbine on each of the twin-screw shafts. After investigation we are satisfied that this turbine has great superiority over the old-style engine in features of particularly essential value in naval vessels of the cruiser class. In this vessel it gives assurance of higher speed by its ability to convert into power all the steam the boilers can produce, whereas the simplicity of its construction and small number of parts are an assurance of its far greater readiness for service under all conditions.

"With particular reference to the circular defining the chief characteristics of these vessels in accordance with the department's designs, the modifications which we submit are, in brief, as follows:

THE BATTERY.

"1. Referring particularly to sketch plan No. 1, it will be observed that eight of the 6-inch guns carried on the gun-deck of the department's design at a height of 14 feet 6 inches above load water line, have been raised to the main-deck level, and together with four of the main-deck guns, are mounted in pairs in six turrets. Therefore, the increase in height of the eight 6-inch guns will be from 14 feet 6 inches to 23 feet above the water line. The only 6-inch guns remaining on the gun-deck are those forward and aft, having a fore-and-aft fire. The result of this change is to give two additional 6-inch guns firing ahead and two firing astern, making the total ahead or astern fire two 10-inch and six 6-inch guns. The 6-inch guns will be inclosed in turrets of which the general features are shown in plan No. 2, consisting of 6-inch armor with 6-inch barbette and a 4-inch ammunition tube leading to the protective deck, the turning mechanism and ammunition supply being operated from a passage below the protective deck.

"2. The design provides for carrying the same number of guns of all calibers as the department's plans, and gives equal protection to all the minor guns, excepting only four 3-inch guns on the upper deck amidships, two on each side.

THE ARMOR PROTECTION.

"3. The armor protection provided on the alternate design is shown in detail on plan No. 3, and the comparative armor protection of this design and the department's plan is clearly indicated on plan No. 1. The principal feature of the change consists in increasing the thickness of the main belt throughout its length between the 10-inch turrets from 5-inch to 6-inch, which at 3,000 yards would render the belt impenetrable by a 6-inch gun, whereas on the department's design the main belt is penetrable by a 6-inch gun and proof only against a 5-inch gun. All the other features of the armor protection correspond with those of the department's design, including the protective deck.

PROPELLING MACHINERY.

"4. In place of the department's design of vertical twin-screw, four-cylinder, triple-expansion engines of a combined indicated horse power of not less than 23,000, we propose to substitute twin-screw turbines of 11,500 horse power each, having 12 feet diameter buckets, and making at maximum power about 300 revolutions per minute. We shall be able to satisfy the department that the steam economy of the proposed turbine will compare satisfactorily with that of the department's design for reciprocating engines. The boiler installation will correspond precisely with the department's conditions. All miscellaneous engineering requirements, auxiliary steam machinery and equipment requirements, will be complied with in accordance with the department's circular, plans and specifications."

The United States Civil Service Commission announces an examination on February 15-16, 1905, at the places mentioned in an accompanying list, to secure eligibles from which to make certification to fill four vacancies at $1,200 per annum each and two vacancies at $1,400 per annum each, in the position of civil engineer, Philippine service, and vacancies as they may occur in that service requiring similar qualifications.

Report of Bureau of Construction and Repair.

One of the most interesting features to our readers of the recently issued annual report of the chief of the Bureau of Construction and Repair of the Navy Department, is the estimate as to the dates of completion of the new ships now under construction. Altogether it is expected that 21 ships of various types will be finished and placed in service during the present calendar year. Of these, five are the first-class battleships of the *Georgia* type, which are the only five ships building with superposed turrets for the heavy guns. These ships were authorized in 1899 and 1900, and it is expected that they will be completed about the end of the year.

The next ships in point of importance are four of the armored cruisers of the *Pennsylvania* class, three of which are scheduled to be finished before the first of April. It is expected that the last cruiser of the *Denver* class, the *Galveston*, will be finished about April 1, and that the first one of the *Charleston* class will be added to the navy list about the first of July.

In addition to these, the two gun boats building by the Gas Engine and Power Company, the two training ships building at the navy yards at Boston and Mare island respectively, and the training brig building at the navy yard at Portsmouth, will be finished by the end of the fiscal year. The five torpedo boats and destroyers remaining uncompleted at the present time will, it is expected, be finished early this year. It will be remembered that these five boats were all authorized by Congress at the opening of our war with Spain, and that, therefore, they have been seven years in building.

The report shows that a total of 8,405 men are employed in the various navy yards and naval stations, of which number about 2,600 find employment in the New York navy yard, and more than 1,400 at Norfolk. It may surprise some to learn that the number employed at Cavite was about 730, this being larger than the number employed at any of the continental yards, except the two above mentioned and Boston.

A Few Collisions.

We are publishing this month photographs of four ships which have been badly damaged in or near the English channel, and have put into Falmouth for repairs. These repairs have been carried on by the local firm of Cox & Company, and by the Falmouth Docks Company, the latter concern having sufficiently large graving docks to receive almost any ship afloat.

The steamship *Marpessa*, of 1,730 tons, ran into a Dutch army transport carrying troops to the East Indies. The collision occurred in the Bay of Biscay. The troops were all saved by the crew of the *Marpessa* and carried to Falmouth where a new bow had to be fitted, the condition of the bow being well shown in the photograph. The Dutch transport was sunk.

The steamship *Universal*, of 1,274 tons, was abandoned off Ushant and towed into Falmouth by the steamship *Emily*. The *Universal* had been struck in a fog by the steamship *Cambodge*, and had had her stern completely sheared off, the after bulkhead alone preventing the vessel from sinking. In spite of the shock a large mirror fastened to this bulkhead was uninjured, and may be seen in the photograph. The crew of the *Universal* were all taken off by the *Cambodge*, but went back to their ship after the *Emily* had taken her in tow and it was seen that she was in no danger of sinking.

The bark *Abernyte* ran into the broadside of the steamship *Tripoli*, but did not sink her, both vessels reaching Falmouth, and both were repaired at the same time in the dry dock.

The fourth photograph is of the Italian steamship *Costanza*, of 2,903 tons, which ran into the rocks off the Cornish coast and was badly damaged.

The photographs were taken by Mr. W. M. Harrison, of Falmouth.

STEAMSHIP UNIVERSAL.
STEAMSHIP MARPESSA.

STEAMSHIP COSTANZA.
BARK ABERNYTE.

NAVAL ARCHITECTURE.*

BY SIR WILLIAM H. WHITE, K.C.B., F.R.S.

PART IV.

INTERNAL COMBUSTION ENGINES.

In common with France and the United States, Great Britain is rapidly developing the construction of oil-motor launches of great speed, and the possible application of internal combustion engines, on a larger scale, to ship propulsion, is receiving attention. Messrs. Thornycroft have designed machinery of this class for a torpedo-boat destroyer of 6,000 H. P., the piston speed being the same as with steam engines. The space occupied by the new type is only about 60 percent of that required by steam engines and boilers, and there would be large savings in weight. This can only be regarded as a sketch design, as it goes very far in power beyond any actual installation, but it is suggestive. For British submarines Messrs. Vickers have made engines up to 300 brake horse power, and the Daimler Company has made engines of equal power. In the small swift launches so far built, it is claimed that the propelling apparatus and fuel for six hours weigh only from one-sixth to one-tenth as much as for a good condensing steam engine and boiler, suitable for boats and capable of developing the same power. There is a great saving in space occupied by propelling apparatus, a large increase of accommodation, and much enlarged power of covering distance. In a good steam engine fitted in boats from 2 to 2 1-2 pounds of coal per horsepower hour are consumed; with oil about one-third that weight suffices.

Besides oil engines and spirit engines, gas engines (using gas made from solid fuel by producers) are under consideration for marine purposes. The boiler and its contained steam and water would disappear in favor of producers, cheaper qualities of coal would suffice for making gas, and it is anticipated that large economies in cost, as well as weight and space, would be effected. Practical steps are being taken to give effect to this idea.

Claims are also made that gas turbines will be brought into use, and the writer has had statements made to him recently that engines of this class of considerable size have been made and worked. As yet, however, there seems no sufficient evidence that the great difficulties inherent in the system have been overcome.

OIL FUEL.

British experience with oil fuel as a substitute for coal has not equalled that of oil-producing countries. Experiments have been made, however, on a considerable scale for marine purposes; the Admiralty having recently resumed the investigation which was begun many years ago and then suspended, while many merchant ships have been fitted for oil fuel. Satisfactory arrangements for efficiently burning oil fuel are now available for British ships, and every one recognizes the enormous saving on shipping oil and transporting it to the furnaces, as well as the advantages obtainable from its greater calorific value. The practical difficulty in Great Britain, however, and probably the crucial point in all countries, is that of adequate supplies of oil at reasonable prices. Statements have repeatedly been made that this difficulty has been overcome, but it remains as real now as it was ten years ago. Coal is holding its own for ship propulsion except in a few special trades.

BRITISH WARSHIPS IN 1904.

The latest type of battleship for the Royal navy, of which the first examples are now approaching completion, is the *King Edward* class, designed by the writer in 1901. These vessels are 425 feet long, 78 feet broad and 16,350 tons displacement. Their engines develop 18,000 horsepower, and the guaranteed speed was 18 1-2 knots for 8 hours. The first vessel tried (the *Commonwealth*) was ballasted to about 2 inches deeper than the designed draft of 26 feet 9 inches, and with 18,500 I. H. P. she exceeded 19 knots. On a 30-hour trial, with 12,770 I. H. P., she attained 17.9 knots, and the coal consumption was 1.68 pounds per horsepower hour. The disposition of armor differs from that of the *Majestic* of 1894 in many respects. The after end of the armored citadel wraps round the base of the after barbette, as in the *Majestic*, and the top of this armor is at the level of the main deck; but this depth of armored side (about 14 1-2 feet) is continued to the bow, maintaining its full thickness until the fore barbette has been passed, and then being gradually diminished to 3 inches at the stem. Abaft the citadel the water-line region is protected by thin side armor. There are two protective decks: one, nearly horizontal, about 9 feet above water, and the other, curved transversely (as in *Majestic*), reaching to the lower edge of the side armor. The four 12-inch guns are mounted in pairs in barbettes and carried on revolving turn-tables with armored shields. Between the barbettes, on the main-deck, is a central battery with 7-inch armor on the sides, containing ten 6-inch quick-firing guns. On the upper-deck, four 9.2-inch guns are mounted in four separate turrets. The side armor is 8 and 9 inches, the barbette armor 12 inches; the total weight of armor and backing is 4,800 tons. All the armor is of Krupp quality. The new feature in the armament is the use of 9.2-inch guns to supplement the 6-inch guns; a change rendered necessary by the fact that improvements in armor manufacture had made the protection given to secondary armaments in recent battleships superior to the penetrating power of 6-inch guns at the long ranges now adopted. Since the writer's retirement three other vessels have been ordered from this design, so that there are now eight of the class building. The hull costs about £400,000, and the armor about the same amount. Propelling and other machinery cost nearly £220,000; gun mountings and torpedo tubes £215,000; and the total cost per ship exceeds £1,337,000, exclusive of armament and ammunition. Fully equipped each ship represents over 1 1-2 millions sterling.

The interval of ten years has raised the displacement of a first-class battleship from 15,000 to 16,350 tons and the cost from £820,000 to £1,337,000, excluding armament. The speed has been increased more than a knot, and great improvements have been made in armor, guns, and gun mountings; the defensive and offensive power being considerably increased.

These features of change in design extend to all classes of modern warships, but it is not possible to illustrate the tendency by references to many classes. Taking armored cruisers, the *Drake* may be contrasted with the *Powerful*, a protected cruiser of 1894. They are practically of the same length, breadth, and displacement; and, as both classes were designed by the writer, it is obvious that personal skill had nothing to do with the result. Owing to changed conditions, it was desired, in the *Drake*, to develop armor protection, to increase speed and to make the armament more powerful as compared with her predecessor. This involved a redistribution of the weights making up the displacement. By changes in freeboard and in superstructures, the abolition of the heavy and costly wood and copper sheathing, which had been thought necessary in the *Powerful* for her special service, and the acceptance of less thicknesses of deck protection, a considerable saving in weight was effected. With the weight thus saved it was possible to give the *Drake* 6-inch side armor and 5-inch casemates and shields; to increase the armament by two 6-inch guns; and to add about 36 percent to the engine power, with a gain of fully a knot in estimated speed. On the other hand, the maximum coal capacity was reduced from 3,000 to 2,500 tons. The *Drake* class cost rather more than one million sterling, exclusive of armament, the armor representing a considerable proportion of the total, and the more powerful engines involving large outlay. The *Powerful* cost less than £700,000; the only thick armor carried was that on casemates and shields, and the protective deck was comparatively inexpensive.

Of the numerous classes of cruisers, both armored and protected, which now form part of the Royal navy, it is impossible to speak on this occasion. New developments are continuously taking place, amongst the most notable in recent years being the construction of a great flotilla of destroyers and a few scouts, to which reference has been made previously. Submarine vessels of the Holland type have been added to the fleet, and auxiliaries to

*Paper read before the International Engineering Congress at St. Louis, October 8, 1904.

fleets—repair and depôt ships, water tanks and colliers—have been built, or are contemplated. According to the latest Parliamentary returns, on March 31, 1904, the British navy included the following vessels, built and building, or to be commenced in 1904: battleships, 67; coast-defence ironclad, 1; armored cruisers, 45; protected cruisers and scouts, 116; unprotected cruisers, 8; torpedo vessels, 32; destroyers, 160; torpedo boats, 91; submarines, 29; a grand total of 549 vessels.

The examples above given for certain classes explain the enormous increase of expenditure on war fleets which has occurred in recent years. The reconstruction of the Royal navy, which took place during the writer's period of office, under arrangements made in successive programmes, involved an expenditure, from 1885 to 1902, of 88 1-2 millions sterling, and the 245 ships of all classes, for which the writer was the responsible designer, had an aggregate value of about 80 millions sterling, exclusive of armaments and stores, or about 100 millions fully equipped. The capital value of the fleet in the same period was about trebled, and became 100 millions, exclusive of armaments. At the end of the French war (1813) the corresponding capital value was 10 millions; in 1860 it was under 18 millions; in 1878, 28 millions. The maintenance of supremacy at sea is a very costly undertaking in modern times, and the responsibility of the naval architect grows continuously.

STABILITY.

In regard to the developments in the theory of naval architecture during the last ten years little need be said. The most marked change has been in the direction of wide extensions of scientific procedure in the designing of ships.

The scientific principles underlying calculations for the stability of ships, and the methods of calculation, have been long determined. For more than a century the use made of these methods was very limited. Their practical application on a large scale received an enormous impetus from the inquiry which followed the loss of H. M. S. *Captain* in 1870. The chief advances made since that date have been the device and perfection of integrating machines, by which great economies of time and labor have been effected, and the accumulation of masses of experimental data for ships of various classes. Formerly, calculations for the stability of merchant ships were the exception. The introduction of novel types and the more general adoption of scientific procedure in design has, in recent years, led to widespread experimental investigation, and to detailed calculations for all classes of merchant ships. Indeed the practice for merchant ships is now very similar, in this respect, to that previously followed for war ships.

One feature of great importance may be mentioned, which has been developed, during the last ten years, by the introduction, in battleships and armored cruisers, of heavy guns with strong armor protection, placed high above water. Personally, the writer recognized the fact, from the first, that such a vertical distribution of weights must produce an unusually high position of the center of gravity, in proportion to the total depth of the ships; and that, even with high freeboard, there would be only moderate ranges in the curves of stability, as compared with preceding battleships and cruisers of high freeboard. For preceding high freeboard types, either for war or commerce, it had been usual and proper to assume that, if the metacentric height was sufficient, there would be ample range; but under the new conditions it seemed clear to the writer that this could no longer be true.

Calculations made (about 1893-94) for battleships of the *Majestic* class and for the cruisers *Powerful* and *Terrible* confirmed this anticipation, and showed that, notwithstanding the very high freeboard, the range of stability was only about 60 degrees. At present one of the most critical questions to be faced by warship designers is that of securing adequate range of stability with heavy loads of armor and armament, which are required to be carried at great heights. In fact, so far as the character and range of curves of stability are concerned, the problems now arising are similar to those which were dealt with, for vessels of moderate freeboard, by scientific members of the committee on designs for ships of war appointed by the British Admiralty in 1871. Their investigations for vessels of the breastwork-monitor type have consequently acquired fresh interest. Although these investigations were conducted on scientific lines, and secured the collaboration of men like Froude, Rankine, and Lord Kelvin, the solutions reached and the practical rules laid down were avowedly, and from the nature of the case could be, only approximate. To treat them as if they were exact and complete solutions, would be distinctly contrary to the views of the investigators themselves.

When guns of heavier calibers and greater lengths have to be mounted at considerable heights above water, in order to increase fighting efficiency, there is a temptation to accept limitations in range of stability, which may be of serious import in war ships exposed to damage in action. Increase in breadth, of course, enables adequate metacentric heights and some addition to range to be obtained, even under the conditions described. But everyone familiar with the subject is aware that while increase in beam, and consequent increase in metacentric height, produces some addition to range of stability, the gain is relatively small if the center of gravity is high in the ship. On the other hand the period of oscillation is rapidly diminished by increase in metacentric height, and quicker rolling is accompanied by loss of steadiness at sea, under critical conditions of wave motion. It is not overlooked that in modern types the greater area of armor protection and the greater vertical depth of armored sides, make ships much less liable to rapid diminution of their stability when exposed to gun fire in action; so that there is reason for accepting a less range of stability in the intact condition than with preceding ships of inferior protection. But the writer's conviction is that the question of range of stability, under existing conditions, does not always receive the attention it deserves; and that the tendency which now prevails to increase the caliber of guns in secondary armaments and to place them on upper decks, makes it most important to thoroughly investigate the conditions of stability for each design before accepting the desired armaments and protection.

As to merchant ships the cases requiring closest study are those incidental to cargo steamers carrying great loads and very diverse cargoes. The designer has no control over the character or stowage of the cargoes. All that he can do is to assume certain conditions as being the worst likely to occur in practice, and to provide for them. Great attention is now given to such problems, and scientific procedure in regard to them is general. Legislation in regard to maximum load lines in British ships has greatly assisted designers in their work, by fixing one important feature. In essentials, that legislation remains practically in the same form as it stood ten years ago.

ESTIMATES OF SPEED AND ENGINE POWER.

In this section of ship design it cannot be said that the last ten years have added any important novelty in procedure; but there has been a large extension in the application of accepted methods based upon scientific investigation. The necessity for progressive steam trials and their thorough analysis is now generally recognized. Model experiments in specially constructed tanks are much more common, and are admitted to be essential to the complete study of designs for ships of unusual form or unprecedented speed. Leading shipbuilding firms are establishing their own experimental tanks; and a movement is now in progress for adding to these private establishments in England, a tank specially devoted to general research work on problems incidental to the movement of solid bodies through water and the efficiency of propellers. Experience to date establishes beyond question the opinion, long held by those most familiar with the subject, that, apart from experimental inquiry, mathematical investigation will never be capable of dealing conclusively with the causes influencing the efficiency of screw propellers, or the selection of the propellers best adapted to a particular ship. Fresh weight has been given to this argument by the introduction of rotary engines with high speed of revolution, demanding propellers of unusual dimensions in relation to the power applied. All these matters are now receiving attention. They cannot but have a marked effect upon the economy and efficiency of future steamships both for war and for commerce. It is unnecessary to reproduce many facts illustrating these general conclusions; a single example must suffice. The *Drake* class of armored cruisers was designed for 23 knots speed on an eight hours' trial. The writer's estimate was that, if the choice of propellers was successful, the actual speed would be about 23 1-2 knots. On the trial of the *Drake*, with the screws first fitted, 30,600 I. H. P. was developed and the corresponding speed was 23.05 knots. These screws had been selected on the basis of experiments with model screws made in the Admiralty tank. From progressive trials, however, it was ascertained that at the higher speeds the slip rapidly increased, and it was obvious that greater blade area was required. New blades were made of the same diameter, rather less pitch, and about 38 percent greater area. With 31,400 I. H. P. the speed attained with these propellers was 24.11 knots, corresponding to 24 knots for 30,600 I. H. P., and 23.05 knots for 26,000 I. H. P. That is to say, the change of propeller blades produced an economy in power of 15 percent at 23 knots, and enabled a knot greater speed to be realized at full power. Equally striking examples might be given from experience with other classes, and particularly with destroyers, all of them indicating the necessity for further experiments on a large scale to supplement model experiments with screws, and to furnish a proper scale of comparison.

One of the latest and most striking examples of the value of tank experiments has been furnished in connection with the design of the great Cunard steamships now building, which are to be capable of maintaining an average speed of 24 1-2 knots across the Atlantic in fair weather. Here, in association with the selection of the most suitable dimensions and form, and the settlement of novel problems arising from the use of four shafts and propellers driven by steam turbines, it would have been impossible to proceed with confidence apart from tank experiments on models. By the courtesy of the Admiralty these experiments have been exhaustively completed with the greatest advantage to the owners and designers of the ships.

In conclusion it is necessary to repeat the statement that within the limits of this paper anything like a comprehensive survey of the progress of British shipbuilding since 1894 is impossible. As one who has been in close touch with fellow workers in all departments, and who has himself been actively engaged, it has been the writer's endeavor to note the chief features in a remarkable period, and to indicate present tendencies. He trusts that the review, imperfect as it is acknowledged to be, will have some interest for the members of this congress.

Havana Auto Races.—It is announced that President Palma has issued a permit for automobile and auto-boat races, to take place in Havana during the month of February. The course for automobiles will be 204 miles on the round trip, being on the San Cristobal road, and will occur on February 8, 9, 10, and 11. The auto-boat tests will take place on the 4th of February and will probably consist of three races. On the last day of the automobile race a tour will be made of the principal points of interest in the province of Havana, the affair ending at night with the parade and carnival.

OBITUARY.

We have to record the death, on the 28th of December, of Thomas F. Secor, at the age of 89. In his day Mr. Secor was one of the best known shipbuilders in the country. He was the builder of the Mare Island navy yard, at San Francisco, California, and the Pensacola navy yard at Pensacola, Florida. During the Civil war he was responsible for the construction of some of the monitors used by the United States, as well as other ironclads and dry docks.

POWERING SHIPS.

BY EDWIN CERIO, NAVAL ARCHITECT.

PART II.

IV. THE RESISTANCE OF SHIPS.

It is an inexplicable but undoubted fact, that quite a number of theories on the resistance of ships have up to 1870 enjoyed much credit, though founded on quite erroneous interpretations of the phenomena of a vessel moving in water. Scott Russell's theory, to mention one, was founded on the assumption that a ship when in motion performed an *excavation* in the water, and that therefore to work her way she had to lift from the center of buoyancy to the surface a mass of water equal to the displacement. If this were true the propulsion of vessels would need an enormous amount of force, but, as Froude observed in his address to the Royal Institute, May, 1876: "It is a point worth noticing what an exceedingly small force, after all, is the resistance of a ship compared with the magnitude of the phenomena involved." Froude further quotes the example of the frigate *Shah*, and says that scarcely anyone seeing her steam at full speed "would be inclined at first sight to credit, what is nevertheless a fact, that the whole propulsive force necessary to produce that apparently tremendous effect is only 27 tons, in fact, less than one two-hundredth part of the weight of the vessel."

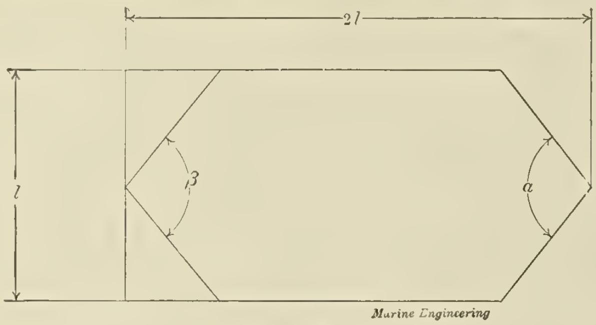


FIG. 1.

Up to the year 1870 nearly all of the numerous formulæ given for calculating the resistance of ships were derived from the expression:

$$W = KAV^2,$$

where A is the midship section area, V the speed, and K a coefficient. Though this formulæ is no more employed in our day to determine the resistance of ships, it may be of some use in the case of prismatic vessels such as pontoons, barges, etc., as it is founded on a sound basis; in fact, if A is the area of a plane moving in a fluid with a certain speed V, and if δ is the density of the fluid, in the unit of time, the plane A will have removed a volume of fluid AV, which will have performed an amount of mechanical work proportional to:

$$\tfrac{1}{2}\,\delta\, AV \times V^2,$$

if this work be equalled to that of the resistance W, $W\,V \sim \tfrac{1}{2}\,\delta\, AV \times V^2$ and

$$W \sim \tfrac{1}{2}\,\delta\, AV^2$$

To take into consideration all the other causes which influence the resistance when the body moving is no longer a plane, the coefficient K has been introduced, thus obtaining the formulæ $W = KAV^2$. Many authors have given a series of values of K which, unhappily, differ much from one another. Accurate researches by Froude have led to the value:

$$K = 11.3.$$

When the formula $W = KAV^2$ is to be used in practice the following values of K may be found of great help for vessels of prismatic form:

When the ratio of length to breadth is from 4 to 6, $K = 10.3$.

In the same conditions but with extremities sharpened $K = 7.2$.

Prismatic vessels ship-shaped at ends, $K = 1$.

The following remarks may also prove useful when considering such vessels:

A prismatic vessel having a square water-line section moving in the direction of the diagonal meets a resistance 1.221 times that which it meets when moving in the direction of the sides.*

The following data show the influence of angles afore and abaft of a prismatic body on its resistance in the water.**

If, in Fig. 1, when $\alpha = 180$ degrees and $\beta = 180$ degrees the resistance is $W = 1$, for

$\alpha = 150$ degrees...... $W = 0.96$	$\beta = 150$ degrees...... $W = 0.95$
$\alpha = 90$ " ...... $W = 0.56$	$\beta = 90$ " ...... $W = 0.90$
$\alpha = 60$ " ...... $W = 0.45$	$\beta = 60$ " ...... $W = 0.86$
$\alpha = 30$ " ...... $W = 0.41$	$\beta = 30$ " ...... $W = 0.84$
$\alpha = 15$ " ...... $W = 0.40$	$\beta = 15$ " ...... $W = 0.82$

THE LAW OF KINEMATIC SIMILITUDE.

To study the resistance of ships by means of their models, it is necessary that the dimensions of ship and model be in a certain ratio α, and that if V is the speed of the vessel and v that of its model,

$$V = v\sqrt{\alpha}.$$

When the speeds V and v satisfy this condition they are called "corresponding speeds." Corresponding speeds produce similar wave configurations. "When two similar vessels move with corresponding speeds, the resistances met by these vessels are proportional to the cubes of their linear dimensions; that is to say, their ratio is equal to the ratio of the vessel's volumes"; on this law, which is Newton's law of kinematic similitude, is founded the study of ships' resistance by means of their models. Were this law true for the whole of the resistance which a vessel meets in water, it would be enough to multiply the model's resistance, and its speed respectively by the third power (α^3) and the square root ($\sqrt{\alpha}$) of the ratio of similitude to obtain the resistance of the ship at the corresponding speed. But the law of similitude does not apply to all the causes which affect the resistance of the ship, and it proves true only for that part of resistance which is due to wave configuration; the other part of the ship's resistance, that is, the skin resistance, must be investigated separately.

The method originally introduced by Froude to apply the law of similitude to ship resistance is the following: By means of tank experiments the total resistance w of the ship's model is determined, and from this the skin resistance w_s is subtracted, thus obtaining the residual resistance w_r. This residual resistance of the model multiplied by α^3 gives the residual resistance W_R of the ship; the ship's skin resistance W_S is calculated separately. The residual resistance comprehends also the secondary resistances, and it may be assumed that these, like the resistance due to wave configurations, also follow the law of similitude. The total resistance may be expressed by:

$$W = W_R + W_S,$$

where:

$$W_R = (w - w_S)\alpha^3;$$

therefore we may also write:

$$W = (w - w_S)\alpha^3 + \frac{W_S}{\alpha^3}\alpha^3,$$

or:

$$W = \left(w - w_S + \frac{W_S}{\alpha^3}\right)\alpha^3 = W_1\alpha^3,$$

having made

$$w - w_S + \frac{W_S}{\alpha^3} = W_1.$$

The law of variation of resistance in proportion with speed may be represented by a curve in which the speeds are taken as abscissæ and the resistances as ordinates. Let the curve (w) Fig. 2, be the diagram of the total resistance of the model; we can also construct a curve (W) with the same abscissæ and having for ordinates the values of:

$$w - w_S + \frac{W_S}{\alpha^3}$$

for the different speeds, as w, w_s and $\frac{W_S}{\alpha^3}$ are known quantities. If the ordinates of the curve W are divided by α^3 and the abscissæ by $\sqrt{\alpha}$, that is, if we read the resistances on a scale $(w \div \alpha^3)$ and the speeds on a scale $(V \div \sqrt{\alpha})$, the curve W will represent the law of variation of the total resistance of the ship.

This original way of applying Froude's theory is very simple, but it does not allow us to compare to the same model a series of ships whose linear dimensions bear to those of the model different ratios of similitude α_1 α_2 α_3 . . . because when the dimension length varies, the values of $\frac{W_S}{\alpha^3}$ also vary, and the same curve of one model could not serve to obtain the resistance of all similar ships. Another method, to be described at a later point, is therefore employed when the resistance of ships is to be determined by means of models.

SKIN RESISTANCE.

The principal feature of modern researches on the resistance of ships is the introduction of a cause of resistance which had been, in the old methods, completely left aside; this is the friction generated by contact of the outside plating with the water, and which causes the skin resistance.

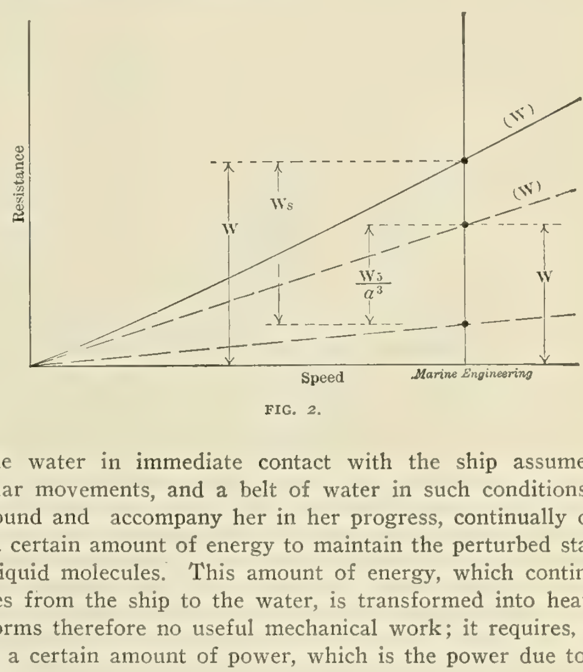


FIG. 2.

The water in immediate contact with the ship assumes irregular movements, and a belt of water in such conditions will surround and accompany her in her progress, continually drawing a certain amount of energy to maintain the perturbed state of the liquid molecules. This amount of energy, which continually passes from the ship to the water, is transformed into heat and performs therefore no useful mechanical work; it requires, however, a certain amount of power, which is the power due to skin resistance.*

The most important geometrical element necessary to determine skin resistance is the *wetted surface* of the ship; strictly speaking, the *reduced wetted surface* ought to be employed, but the actual surface is always considered, and is, practically, the same in most cases. The following formulæ give fairly accurate values of the wetted surface:

$$S = 15.6\sqrt{D.L}$$
$$S = L\,(1.7H + \delta B),$$

Where:

S is the wetted surface in square feet,

---

*Gareis—Wasserwiderstand des Schiffes.

**Scribanti—Lezioni di teoria della nave.

*I have found it appropriate, in the following remarks, to repeat only that part of the theory of skin-resistance which is indispensable for practical use, when powering ships. This theory is dealt with, by Prof. W. F. Durand, with great clearness and competence, and all those especially interested in the subject may profitably consult his book, "Resistance and Propulsion of Ships."

D the displacement in tons,
L the length in feet,
H the draft in feet,
B the beam in feet,
δ the block coefficient.

These formulæ may be always applied in practice; when particular accuracy is required, other means of determining the wetted surface with greater exactness are always at hand.

Calling:
W_s the skin resistance in pounds,
f the coefficient of skin resistance,
S the area of wetted surface in square feet,
n an index for the variation of resistance with speed,
the general formula by means of which skin resistance may be determined is:

$$W_s = f\,Sv^n.$$

The coefficient *f* depends mostly on the nature of the wetted surface, on the density of the water, and varies indirectly with the length of the ship. It is affected by temperature, but only slightly, and depth and pressure of water have no influence upon it.

The exponent *n* is influenced by the roughness of the outside plating, and by the length of the ship.

Table V contains the values of *f* and of *n*, to be adopted in each case.

Experiments carried out at Spezia, Italy, to ascertain the influence of paint on resistance seem to prove that the quality of paint, practically, does not affect skin resistance. If *f* is the coefficient of skin resistance when the outside plating is freshly painted and perfectly smooth, the coefficient when (1) the outside plating is not painted is 1.4 *f;* (2) the ship has a foul bottom is 2 *f;* (3) the ship is covered with incrustations is 5 *f*.

TABLE V.—VALUES OF THE COEFFICIENT OF SKIN-RESISTANCE AND OF THE INDEX FOR THE VARIATION OF RESISTANCE WITH SPEED.

For Ships* (in Salt Water).					For Paraffin Models (in Fresh Water).		
Length of Ship, Feet.	According to Froude. Values of: *f*.	According to Froude. Values of: *n*.	According to Tidman. Values of: *f*.	According to Tidman. Values of: *n*.	Length of Model, Feet.	According to Tidman. Values of: *f*.	According to Tidman. Values of: *n*.
8	0.01197	1 825	....	......	2	0.01176	1.94
9	0.01177	1,825	....	......	3	0.01123	1.94
10	0.01161	1,825	0.01124	1.8530	4	0.01083	1.94
12	0.01131	1,825	....	......	5	0.01050	1.94
14	0.01106	1,825	....	......	6	0.01022	1.94
16	0.01086	1,825	....	......	7	0.00997	1.94
18	0.01069	1,825	....	......	8	0.00973	1.94
20	0.01055	1,825	0.01075	1.8490	9	0.00953	1.94
25	0.01029	1,825	....	......	10	0.00937	1.94
30	0.01010	1,825	0.01018	1.8440	10.5	0.00928	1.94
35	0.00993	1,825	....	......	11.0	0.00920	1.94
40	0.00981	1,825	0.00998	1.8397	11.5	0.00914	1.94
45	0.00971	1,825	....	......	12,0	0.00908	1.94
50	0.00963	1,825	0.00991	1.8357	12.5	0.00901	1.94
60	0.00950	1,825	....	......	13.0	0.00895	1.94
70	0.00940	1,825	....	......	13.5	0.00889	1.94
80	0.00933	1,825	,......	......	14.0	0.00883	1.94
90	0.00928	1,825	....	......	14.5	0.00878	1.94
100	0.00923	1,825	0.00970	1.8290	15.0	0.00873	1.94
120	0.00916	1,825	....	......	16.0	0.00864	1.94
140	0.00911	1,825	....	......	17.0	0.00855	1.94
160	0.00907	1,825	....	......	18.0	0.00847	1.94
180	0.00904	1,825	....	......	19	0.00840	1.94
200	0.00902	1,825	0.00944	1.8290	20	0.00834	1.94
250	0.00897	1,825	0.00933	1.8290	....	....	....
300	0.00892	1,825	0.00923	1.8290	....	....	....
350	0.00889	1,825	0.00916	1.8290	....	....	....
400	0.00886	1,825	0 00910	1.8290	....	....	....
450	0.00883	1.825	0.00906	1,8290	....	....	....
500	0.00880	1,825	0.00904	1.8290	...	....	....
550	0.00877	1,825	...	......	....	....	....
600	0.00874	1,825	....	......	....	....	....

*The values of *f* and *n* are for steel ships with the bottom perfectly clean and well painted.

N. B.—For intermediate values of the length, the table is used with interpolation.

WAVE RESISTANCE AND ECONOMICAL SPEED.

The motion of a ship causes the surrounding water to assume what is called a *wave configuration.* To maintain this wave configuration it is necessary that a certain amount of energy be continually transmitted from the vessel to the liquid particles which surround it, or in other words, that a part of the propelling power be employed to neutralize the work of wave resistance. The mass of water which forms a wave does not advance, but the wave configuration does, and in advancing it abandons half of the energy which it required for its *formation;* therefore, when the vessel moves, producing a wave configuration, it is necessary that the part of the energy required to maintain the configuration only, and not that part required for the formation of the wave, should continually be furnished, in the shape of horse power due to wave resistance.

The following remarks apply in a general way to wave resistance:

Wave resistance depends upon speed, and, at a given speed, upon the length of the ship. For a given length there must be a certain speed, above which the resistance begins rapidly to increase, and this speed is proportional to the square root of the ship's length. This fact may be observed in Fig. 3, where some typical curves of resistance are shown for four vessels; the coefficient δ, given for each, is the block coefficient. It is of great interest to more closely investigate the characteristics of the above-mentioned speeds, which, though very seldom considered in practice, have an importance which ought not to be overlooked by any ship designer.

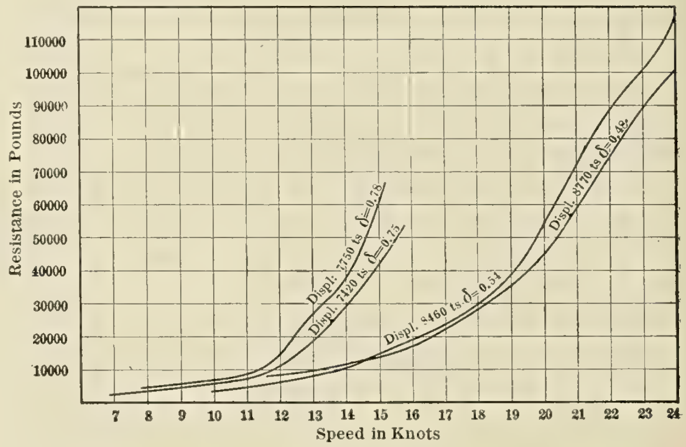


FIG. 3.

Many shipbuilders have a vague idea of what is generally called the *economical speed of a ship,* and its relation to the ship's length, associating this idea with the notion of the *smallest amount of power* required to propel a vessel in given conditions. Mr. E. Tennyson-D'Eyncourt, in a very important paper read before the Institution of Naval Architects,* analyzing the trial results of many ships, gives a method of defining the *limiting speed;* he says every ship has an appropriate limit of speed, beyond which it is uneconomical to attempt to drive her; this would lead to define economical speed as the limit beyond which every increase in speed requires a disproportionate increase in power. But this and other abstract definitions convey only a conventional idea of the influence which form and dimensions have on wave resistance. A closer study of this most important phenomenon, viz., the existence of a certain characteristic speed for every ship, will give a more concrete notion of a fact which ought always to be kept in view when powering ships.

To avoid the elaborate discussion which leads to a very simple expression of wave resistance, I will recall this expression and omit the demonstration, as it is only from the final result that I intend to draw the conclusions which will give a clear idea of what has to be understood under "economical speed." Calling:
W the wave resistance,
b the mean value between the breadth of a wave forward and that of a wave aft,

*"On the Limits of Economical Speed."

h_1 and h_2 respectively the heights of these waves,

$h'_1 = Kh_1$ the height of the forward wave when its configuration has reached the point at which the after wave is formed, K being a constant,

m the ratio between the distance apart of the two wave crests, and the length of the ship,

L the length of the ship,

V the speed,

g the acceleration due to gravity,

α and β two constants resulting from the equations,

$$h_1 = \alpha V^2 \qquad h_2 = \beta V^2,$$

the expression referred to of wave resistance may be put under the form:

$$W = b\left\{\alpha^2 + \beta^2 + 2K\alpha\beta \cos\frac{gmL}{V^2}\right\} V^4.$$

We shall consider only the factor cos $\frac{gmL}{V^2}$, in which g and m are constants, and therefore L and V^2 are the only terms which affect the wave resistance; the following discussion, though aiming to give a practical and clear idea of what is generally called economical speed, is purely theoretical, and its conclusions cannot be applied, so to speak, numerically. The factor cos $\frac{gmL}{V^2}$ may be written cos $\frac{gm}{G^2}$ where the constant $G = \frac{V}{\sqrt{L}}$ and a diagram

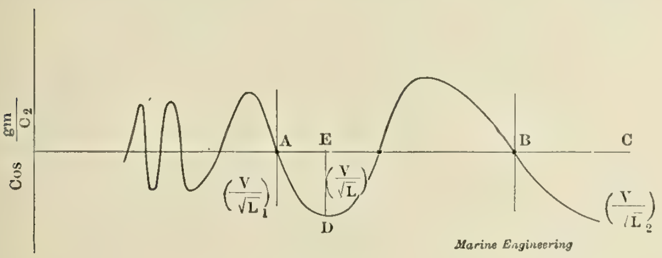


FIG. 4.

constructed with the values of cos $\frac{gm}{G^2}$ as ordinates and those of G as abscissæ will have the form shown in Fig. 4. There are some values of V and L which will make the factor cos $\frac{gmL}{V^2}$ negative and others which make it positive.

The expression of wave resistance shows clearly that the resistance will be smaller, within certain limits of speed, when cos $\frac{gmL}{V^2}$ has the greatest negative value; in the region graphically limited by A and B, in Fig. 4, between the values $\left(\frac{V}{\sqrt{L}}\right)_1$ and $\left(\frac{V}{\sqrt{L}}\right)$ of the abscissæ there is a value $\left(\frac{V}{\sqrt{L}}\right)$ for which cos $\frac{gm}{G_2}$ has a maximum negative value; *in this region*, the length of the ship being L, it may be said that V is the economical speed, because the wave resistance is here the smallest for values of G between A and B. In the formula of resistance the value of the constant K is proportional to the speed. The value of the latter may become so great that to avoid a disproportionate increase of resistance it may be advisable to increase L; these *theoretical* conclusions are confirmed by practice. Mr. Tennyson-D'Eyncourt deduces many important conclusions in his paper on the limits of economical speed, the following being those of more practical value when estimating horsepower. A relation between the coefficient of fineness, the length of parallel body, and the limits of economical speed is given in the following table:

TABLE VI.

Coefficient of Fineness.	Parallel Body as Percentage of Total Length of Ship at the W. L.	Limiting Economical Speed in Knots as Percentage of $\sqrt{L}$ in Feet.
0.5	0	100
0.6	14	86
0.7	30	68
0.8	49	48

The I. H. P. at the limiting speed is varying as the 4th power of the speed, and varies in increasing ratio until at about 12 percent above the limiting speed it is varying as the 7th power of the speed.

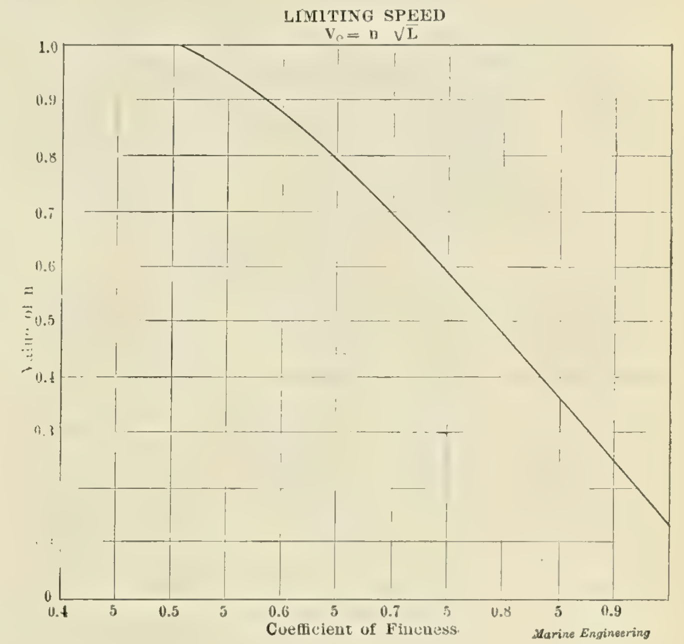


FIG. 5.

The wave horsepower varies as V^7 at the limiting speed and as V^{10}, or sometimes at a higher power of V, at 12 percent above the limiting speed; at this point, viz., at 12 percent above the limiting speed, the wave horsepower is approximately equal to the skin horsepower. The values of the Admiralty's coefficient, $C = \frac{D^{\frac{2}{3}} V^3}{IHP}$ are as follows:

TABLE VII.

Length of Ship in Feet.	Values of C at the Limiting Speed.	Values of C when Skin HP = Wave HP.
200	225	188
300	256	207
400	278	224
500	295	237
600	310	246

In analyzing the trial results of ships, Mr. Tennyson-D'Eyncourt has assumed the performance:

$$E = \frac{EHP}{IHP} = 0.5.$$

In a study of this nature it is thought advisable not to rely upon arbitrary coefficients of performance, and to consider, whenever it is possible, the effective horsepower, applying afterward, in every single case, the particular value of the coefficient E, which appears to be best suited. I have analyzed the results of experiments carried out with models of actual ships. Table VIII contains, besides the geometrical characteristics of a number of ships of different types, the economical speed and the E. H. P. due to skin resistance and wave formation at different speeds given in

TABLE VIII.—RELATION BETWEEN E. H. P. AND THE LIMITING ECONOMICAL SPEED.

No.	Description of Vessel.	Length, Ft.	Breadth, Ft.	Draft, Ft.	Wetted Surface, Square Ft.	Coefficient of Fineness, δ.	Displacement, Tons.	Effective Horse Power at Speeds Given in Percentage of the Economical Speed.																Economical Speed, Knots.
								60		70		80		90		100 (Economical Speed)		110		120		130		
								EHP_W	EHP_F	EHP_W	EHP_F	EHP_W	EHP_F	EHP_W	EHP_F	EHP_W	EHP_F	EHP_W	EHP_F	EHP_W	EHP_F	EHP_W	EHP_F	
1	Cargo-boat No. 1.	360.9	43.4	22.6	25,890	0.780	7,750	...	...	94	175	120	254	155	360	210	480	300	.....	.	.....	......	....	10.
2	Cargo-boat No. 2.	360.9	43.4	22.6	25,490	0.750	7,420	50	156	83	242	131	352	185	485	272	645	520	835	940	1,070	1,360	1,750	11.2
3	Passenger steamer No. 1.	442.9	53.6	22.9	29,500	0.540	8,460	238	930	487	1,400	950	2,080	1,750	2,900	3,480	3 900	6,200	5,100	8,800	6,500	11,500	8,150	20.
4	Passenger steamer No. 2.	442.9	53.56	22.95	30 500	0.563	8,880	160	890	430	1,400	880	2,040	1,740	2.850	3,850	3,850	9,000	5,150	.....	.....	......	.....	19.6
5	Passenger steamer No. 3.	492.1	55.8	22.9	34,090	0.485	8,770	450	1,480	840	2,300	1,640	3,350	3,340	4 700	6 400	6,350	9,300	7,850	.....	.....	......	.....	22.7
6	Passenger steamer No. 4.	442.9	55 8	22.9	29,800	0.600	9,670	186	740	395	1,140	650	1,750	1,270	2,410	2,260	3,250	3,620	4,120	6,550	5,500	9,200	7,000	18.6
7	Passenger steamer No. 5.	288	36.58	13.78	11,680	0 490	2,150	56	236	113	365	239	535	475	760	810	1,000	1,370	1,340	2,300	1,660	4,700	2,200	17.20
8	Passenger steamer No. 6.	288	37.2	13.78	12,050	0.530	2,200	20	225	68	330	183	480	385	670	920	920	1,490	1,200	2,160	1,500	.. ...	.....	16.50
9	Military transport......	209.9	37.7	11.66	8,700	0.525	1,380	74	106	111	164	173	236	266	321	455	435	760	580	980	680	1,650	950	14.2
10	Battleship *Re Umberto*....	400.3	76.3	24.44	34,100	0.520	12,650	425	1,030	815	1,580	1,460	2,320	2,600	3,240	5,650	4,400	9,000	5,800	12,500	7,400	......	....	19.60
11	Cruising ship....	305.1	50.9	19.68	16,800	0.494	4,300	180	360	306	575	525	845	935	1,165	1,660	1,590	3,100	2,120	.....	.....	......	.....	17.6
12	Cruiser *Piemonte*......	304.1	38.2	15.28	13,220	0.495	2,518	...	286	...	440	....	640	306	915	515	1,210	1,000	1,600	2,240	2,040	5,100	2.600	17.6

percentages of the economical speed V ; this has been each time determined by means of the formula:

$$V_E = n\sqrt{L}.$$

where L is the length at the water line in feet, and n a coefficient obtainable from the diagram shown in Fig. 5.

With this rather long digression on economical speed, it is intended to call attention to a problem which is intimately connected with the general problem of powering ships—the problem of finding the most favorable relation between the forms of vessels and the speeds they have to attain under fairly economical conditions.

Practically the elements which mostly influence wave resistance are displacement, length, and speed; calling p an experimental coefficient, according to Taylor the wave resistance may be expressed by the formula:

$$W_W = p \frac{D^{\frac{2}{3}}}{L} V^4.$$

W is the resistance in pounds,
L the length of the ship in feet,
D the displacement in tons,
V the speed in knots, and
p a coefficient which may be assumed:

0.365 for vessels with very fine lines and a great ratio of length to breadth;

0.400 for vessels with very fine lines and a moderate ratio of length to breadth;

0.440 for vessels with very fine lines and a small ratio of length to breadth;

0.475 for vessels of full forms.

Summing up the wave resistance and skin resistance, determined with the given formulæ, the total resistance may be obtained, and this is always the most appropriate element to rely upon when estimating the I. H. P. of a ship; the result thus obtained may be controlled by the use of I. H. P. constants given in Tables III., IV*a.*, and IV*b.*

(To be continued.)

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports under date of January 10, 1905, the following degree of completion of vessels building for the United States Navy:

BATTLESHIPS.			Degree of Completion, Per Cent. Dec. 1.	Jan. 1.
Virginia	19 knots.	Newport News Co.	73.43	75.24
Nebraska	19 "	Moran Brothers Co.	63.64	64.91
Georgia	19 "	Bath Iron Works	69.67	71.94
New Jersey	19 "	Fore River Shipbuilding Co.	72.2	74.3
Rhode Island	19 "	Fore River Shipbuilding Co.	75.1	77.1
Connecticut	18 "	Navy Yard, New York, N. Y.	58.71	61.51
Louisiana	18 "	Newport News Co.	64.73	66.5
Vermont	18 "	Fore River Shipbuilding Co.	29.5	31.5
Kansas	18 "	New York Shipbuilding Co.	35.6	40.1
Minnesota	18 "	Newport News Co.	50.24	52.84
Mississippi	17 "	Wm. Cramp and Sons	15.26	17.84
Idaho	17 "	Wm. Cramp and Sons	13.4	15.39
ARMORED CRUISERS.				
Pennsylvania	22 knots.	William Cramp and Sons	97.03	98.25
West Virginia	22 "	Newport News Co.	97	98.5
California	22 "	Union Iron Works	66.7	68.7
Colorado	22 "	William Cramp and Sons	98.42	99.27
Maryland	22 "	Newport News Co.	93.41	95.14
South Dakota	22 "	Union Iron Works	64.1	65.9
Tennessee	22 "	William Cramp and Sons	58.71	60.53
Washington	22 "	New York Shipbuilding Co	55.3	60.7
SEMI-ARMORED CRUISERS.				
St. Louis	22 knots.	Neafie and Levy Co.	56.6	58.5
Milwaukee	22 "	Union Iron Works	63.2	65.1
Charleston	22 "	Newport News Co.	86.06	88.32
PROTECTED CRUISERS.				
Chattanooga	16½ kts.	Lewis Nixon	99.13	99.13
Galveston	16½ "	Wm. R. Trigg Co.	95.	96.
GUNBOATS.				
Dubuque	12 knots.	Gas Engine and Power Co.	72.3	77.6
Paducah	12 "	Gas Engine and Power Co.	68.4	73.1
TRAINING SHIPS.				
Cumberland	Sails ...	Navy Yard, Boston	85.	88.
Intrepid.	"	Navy Yard, Mare Island	67.5	72.
TRAINING BRIG.				
Boxer	Sails....	Navy Yard, Portsmouth	95.	96.
TORPEDO BOATS.				
Stringham	30 knots.	Harlan and Hollingsworth	99.	99.
Goldsborough	30 "	Wolff and Zwicker	99.	99.
Nicholson	26 "	Lewis Nixon	99.	99.
O'Brien	26 "	Lewis Nixon	98.5	99.

THE REPORT OF THE MERCHANT MARINE COMMISSION.

(EXTRACTS.)

A consideration of the serious disadvantages which American ship owners and seamen must meet brings us to the definite, imperative question: What remedy does the Merchant Marine Commission propose to Congress.

Our answer is embodied, as the result of eight months of inquiry and reflection, in the bill "To promote the national defense, to create a force of naval volunteers, to establish American ocean-mail lines to foreign markets, to promote commerce, and to provide revenue from tonnage."

For several years the navy department has been urging Congress to authorize a naval reserve of professional officers and seamen of the merchant service, who shall be in effect a militia of the sea, holding the same relation to the regular navy that is held to the regular army by the organized state militia and national guard.

OUR NEED OF A REAL NAVAL RESERVE.

The United States is the only maritime power, except Russia, which has not made provision for this essential factor of national defense. There is, it is true, a naval militia now existing in a few states, but as a rule it is composed of landsmen and is valuable in war only as an auxiliary in coast and harbor protection, where its advantage is unquestioned. But a naval reserve in the true sense, composed of men habituated to the sea, trained in its difficult work and hardened to its perils, has now virtually no existence in the United States, and nobody understands this better than the good and loyal officers of the state forces, especially those who, because of our sheer lack of such a reserve, were hastily drawn into the naval service on converted yachts or tug boats, or deep-sea cruisers, in the war with Spain. Not a few militia officers and men had at that time their first experience out of sight of land, and for the first time saw the sun go down behind an ocean horizon, "off soundings."

There is, as has been said, one other maritime power besides the United States that is destitute of a trained seafaring reserve, and is in the same plight of fatuous unpreparedness. As a neutral observer, quoted by Rear-Admiral Luce to the commission, said of the Russian Baltic squadron before it sailed away:

> The units of the ships' companies are brave, but as a rule are wanting in the high-sea experience and the elasticity that enable the seamen of the American and British navies to adapt themselves to new and difficult responsibilities as they arise. Nor do the temperaments and traditions of the composite races that man the ships serve to correct these deficiencies. The service is compulsory, not voluntary, and a good portion of the crews is drawn from the interior. The merchant marine is relatively too unimportant to provide a proper nucleus of seamen, and the consequence is that many of the men serving on board ship have no sea aptitude, and are found afloat only because they have drawn an unlucky number in the conscription.

Russia exhausted her best officers and trained men in the first squadron, whose ships now lie sunk at Port Arthur or hide dismantled in the neutral harbors of the Yellow sea. It is not comfortable to think that but for our unbroken victories in the hundred days' war with Spain, Russia's experience with the Baltic squadron might have been our own. It is the evidence of the admiral commanding on the coast of Cuba in that war that the United States had set afloat all its educated officers and skilled seamen in its first battle line, and that if a reverse had come there would have been no crews to man another fleet, even had the new ships been available.

At the present time it is well known that new ships and good ships are being laid up at the navy yards because there are no officers for them, and because the regular navy quota of enlisted men is insufficient for the demands of routine peace service.

THE NAVAL VOLUNTEERS.

The bill as drafted by the commission proposes, as the first essential step in the rehabilitation of our merchant shipping, to create a force of naval volunteers composed of the best officers and men of our merchant ships and deep-sea fishing vessels, and, having created this force, which must necessarily be small at first, to provide means for its healthy and sure expansion. As an inducement to enroll, and in frank recognition of the peculiar national value of a thorough-going seaman, a substantial retainer is offered ranging from $100 a year for the master or chief engineer of a large steamship to $25 for a sailor or fireman, and $15 for a boy. It is understood, of course, that officers and men shall receive regular pay, besides this retainer, during their period of actual naval instruction, and the terms and conditions of this period, which at first cannot be long, and the regulations and qualifications of the service are left, as they ought to be, to be prescribed by the Secretary of the Navy.

Section 2 of the bill authorizes the payment of an annual subvention of $5 per gross registered ton for every vessel, steam or sail, engaged for twelve months in the foreign trade or deep-sea fisheries, $4 for nine months, and $2.50 for six months, provided that the vessel carries among her crew a certain proportion of naval volunteers, and provided further, that the vessel is held at the disposal of the government in war, carries the United States mails, if so required, free of charge, maintains an efficient rating, and makes all ordinary repairs in the United States.

FOR CARGO CARRIERS ESPECIALLY.

To the inevitable question, Will this naval subdivision of $5 per gross ton per annum, payable to a given vessel for no more than ten years, suffice to solve the whole problem of our ocean shipping, creating not only a fleet of capacious and useful cargo ships, but a fleet of fast and luxurious passenger ships?—to this question the commission will frankly reply that no such complete result is to be expected. Regular mail liners of adequate speed on certain important routes are provided for in another way in another section. But this naval subvention of $5 per gross ton does effectually bridge the difference of cost of construction and cost of maintenance, based on wages here and abroad, so far as concerns the average freighting vessel, steam or sail. To this extent it does equalize conditions, and thereby does give our merchant ships a fair fighting chance again upon the ocean.

Take, for example, the actual case of a new steam freighter, a typical cargo vessel, of 3,750 gross tons. Her fixed charges, based on crew wages and maintenance and higher cost of construction, would be, approximately, $13,000 a year greater than those of a British vessel of the same class, with a British crew—if a Chinese or Lascar crew, the difference would be four or five thousand dollars greater. Such a typical American ship would earn a subvention for a year's service, at $5 per gross ton, of $18,750, evening conditions, and perhaps a little more, by way of encouragement to the owners to build new vessels, employ more naval volunteers, and help to make new markets for American commerce.

It is to be noted that one even rate of subvention of $5 per gross ton is provided for all vessels, sail craft included. This is the fairest plan that possibly can be framed. It is simple and intelligible. It is proof against all charges of favoritism and discrimination. Moreover, there is more than one urgent reason why sail vessels should have the same rate as steamers. Our present fleet includes many sail ships of high commercial efficiency. They are often still the pioneers of commerce, visiting new ports where trade is too small or channels too shallow for the steamers. They are the cheapest carriers of certain important cargoes, and their presence is everywhere a check upon exorbitant steam rates.

NOT ENOUGH FOR FAST, HIGH-COST VESSELS.

This proposed rate of $5 per gross ton is unquestionably sufficient to equalize conditions for American sail vessels as against foreign sail vessels, save in the case of the excessively subsidized fleet of France. This same rate, as has also been said, is sufficient to equalize conditions for American cargo steamers, save in exceptional instances. The commission is prepared to anticipate the criticism that this naval subvention will not of itself encourage the building of swift and expensive steamships. Indeed, we are ready to admit this without controversy.

We are frank to say, moreover, that it is our deliberate judgment that in the restoration of the American merchant marine it is the useful, hard-working cargo ship of steam and sail which should have the first and friendliest consideration. For the American people, though they are now sending many compact manufactured goods abroad, are still in the main producers of bulky commodities, so far as concerns their export commerce. Grain, provisions, cotton, lumber, cattle—things like these still make up the greater part of the value, as they do of the volume, of American shipments to foreign countries.

It cannot be too strongly emphasized that the naval subventions offered in Sections 2, 3, and 4 of the proposed bill are not bounties outright or mere commercial subsidies, such as many of our competitors give, but are distinctly based on important public services rendered and to be rendered by the ships and ship owners that receive them. As to the constitutionality and expediency of such guarded subventions as these there can be no question.

NEW OCEAN MAIL ROUTES.

Wherever throughout the country the commission has held its hearings the evidence has been unanimous in favor of the principle of the present ocean mail act, approved March 3, 1891, and a very earnest desire has been expressed for its extension. When this law was passed the rates of compensation originally proposed were cut down about one-third by Congress. Experience has amply proved that this reduction was an error, for, though the older American mail lines have been sustained and developed by the law of 1891 and a few new lines have been created, yet the law has not sufficed to give the United States a complete system of mail communication with the great ports of the world and the chief markets for American merchandise. The American ocean mail lines now operating under contracts provided by the law of 1891, and the compensation received in the fiscal year 1904, are stated by the superintendent of foreign mails as follows:

American Line, New York to Southampton	$690,483.20
Oceanic Line, San Francisco to Australasia	283,203.00
New York and Cuba Mail, New York to Cuba and Mexico	206,082.00
Red D Line, New York to Venezuela and Dutch West Indies	103,325.00
American Mail, Boston and Philadelphia to Jamaica	92,748.00
Total	$1,375,841.20

In the proposed bill not one dollar is added to the expenditure for any one of these five established contract lines. They are left exactly as they are at present, fulfilling, under the law of 1891, their agreements with the government.

Moreover, this law of 1891 is not repealed, and it is not amended except as to certain specific new routes to be established and the new requirements of naval volunteers. Contracts authorized on these new routes are to be made in general in the manner provided for under the existing law, which has stood the test of almost fourteen years of actual experience.

But in one important particular the law of 1891 has undeniably failed. Its reduced compensation has not sufficed to establish contract mail lines to the greater countries of South America, to Central America, to Africa, or to the Orient. Therefore the commission recommends in the proposed bill a substantial increase of compensation on certain specified routes where American steam service will be most likely to increase the foreign markets for American merchandise. These new routes are:

THE NEW SERVICES.

First. From a port of the Atlantic coast of the United States to Brazil, on steamships of the United States of not less than 14 knots speed, for a monthly service at a maximum compensation not exceeding $150,000 a year, or for a fortnightly service at a maximum compensation not exceeding $300,000 a year.

Second. From a port of the Atlantic coast of the United States to Uruguay and Argentina, on steamships of the United States of not less than 14 knots speed, for a monthly service at a maximum compensation not exceeding $187,500 a year, or for a fortnightly service at a maximum compensation not exceeding $375,000 a year.

Third. From a port of the Atlantic coast of the United States to South Africa, on steamships of the United States of not less than 12 knots speed, for a monthly service at a maximum compensation not exceeding $187,500 a year, or for a fortnightly service at a maximum compensation not exceeding $375,000 a year.

Fourth. From a port of the United States on the Gulf of Mexico to Brazil, on steamships of the United States of not less than 12 knots speed, for a monthly service at a maximum compensation not exceeding $137,500 a year, or for a fortnightly service at a maximum compensation not exceeding $275,000 a year.

Fifth. From a port of the United States on the Gulf of Mexico to Cuba, on steamships of the United States of not less than 14 knots speed, for a semi-weekly service at a maximum compensation not exceeding $75,000 a year.

Sixth. From a port of the United States on the Gulf of Mexico to Central America, on steamships of the United States of not less than 12 knots speed, for a weekly service at a maximum compensation not exceeding $75,000 a year.

Seventh. From a port of the United States on the Gulf of Mexico, to Mexico on steamships of the United States of not less than 12 knots speed, for a weekly service at a maximum compensation not exceeding $50,000 a year.

Eighth. From a port of the Pacific coast of the United States, via Hawaii, to Japan, China, and the Philippines, on steamships of the United States of not less than 16 knots speed, for a monthly service at a maximum compensation not exceeding $300,000 a year, or for a fortnightly service at a maximum compensation not exceeding $600,000 a year.

Ninth. From a port of the Pacific coast of the United States to Japan, China, and the Philippines, on steamships of the United States of not less than 13 knots speed, for a monthly service at a maxmium compensation not exceeding $210,000 a year; or for a fortnightly service, at a maximum compensation not exceeding $420,000 a year.

Tenth. From a port on the Pacific coast of the United States to Mexico, Central America, and the Isthmus of Panama, on steamships of the United States of not less than 12 knots speed, for a fortnightly service at a maximum compensation not exceeding $120,000 a year.

Provided, That the requirements of this section as to the rates of speed shall be deemed to be complied with if said rates are developed during a trial of four hours' continuous steaming at sea in ordinary weather in water of sufficient depth to make the test a fair and just one, and if the vessels are maintained in a condition to develop such speed at any time while at sea in ordinary weather. This trial shall be made under the direction and supervision of a board of naval officers which the Secretary of the Navy shall appoint upon the application of the owner or owners of the vessel to be tested.

It will be recognized that in every instance these proposed lines follow natural and important trade routes, and that several of them are valuable, not only for the commercial, but for the political relations which a regular American steamship service will assuredly promote.

NEARLY ALL NEW ROUTES.

As a rule, the ten new ocean mail routes specified in the proposed bill must be created from the beginning—not only the lines, but the ships themselves. There is not one American steamer now running to Brazil, not one to Argentina, not one to South Africa. On the four gulf routes but one American steamer is now found—on the short line to Cuba. In the Pacific ocean the situation is somewhat different. A service from San Francisco to China, Japan, and the Philippines is now maintained by five American steamers of the Pacific Mail and three British steamers of the Occidental and Oriental Company. If the Pacific Mail were to seek the proposed contract, the three British vessels would have to be displaced by new ships of American construction. There is not now, therefore, an "existing line" on this San Francisco route, as the proposed bill contemplates such a service.

Out of the ports of Puget sound only two American steamers of the liner type now run to the Orient and the Philippines. Four other ships of at least equal size and speed would have to be secured to provide a contract service. On this northern route also there is no "existing line," such as would be required by the proposed subvention.

NO "OCEAN GREYHOUNDS."

Frankly, these proposed new mail subventions do not look to the creation of an "ocean greyhound" class. Almost the only "greyhounds" in the world are to be found on a few North Atlantic lines to Europe. It has seemed to the commission that the most useful mail steamships for distant commerce and the mail steamships which the American people most desired at the present time were modern, efficient vessels, combining moderate speed with large cargo capacity. Such are the steamships called for by the mail subventions of the proposed bill. Their speed, it is believed, is adequate but not excessive. Commercial value is nowhere sacrificed to mere record breaking. At the same time, the stipulated speed is believed to be always at least equal, and in most instances superior, to the average rates of foreign steamers now running in the same or similar services.

For example, only two of all the foreign vessels that last year received United States mails at New York for South America possess even a nominal speed of 14 knots, the rate required from all the new ships of our proposed lines to Brazil and Argentina. Foreign steamers from New York to South Africa are now from 8 to 11 knots, and 10 knots is above the average speed of the foreign craft now trading within the Gulf of Mexico.

On the transpacific routes, the fastest ships now afloat are American built, and belong to the Pacific Mail Company. The required speed for steamers on the North Pacific line (13 knots) is 3 knots less than via the Hawaiian line, but the northern route is the shorter to the Orient, and the winter voyages are often too rough and stormy for high speeding. The three British North Pacific liners are nominally of 16 knots, but it is understood that they are never driven to their maximum.

A NAVAL RESERVE FLEET.

Just as required by existing law, whose safeguards are in no way relaxed, the contracts for the new ocean mail routes of the proposed bill must be awarded, after public advertisement, in free and fair competition, to the lowest responsible bidder offering terms satisfactory to the Post-Office Department, and the ships offered can receive no other subvention or bounty from the United States. As required by existing law, the new mail steamships must be built under naval inspection, and the faster of them must be strengthened to mount powerful guns as armed auxiliary cruisers, while the slower vessels serve as equally indispensable transports or supply ships. The speed of all must be tested on an official trial and certified by the Navy Department, and all these mail ships, of any speed, must be held at the disposal of the government in war. Moreover, they must all carry a quota of men and boys of the naval volunteers. Thus there is guaranteed a new naval reserve of both ships and seamen, and an important reinforcement not only of the commercial power but of the defensive power of the United States.

THE TONNAGE-TAX PROPOSITION.

There now remains to be considered the fourth and last feature of the proposed bill. That is a plan, outlined in Section 8, to increase the tonnage taxes on all vessels, American and foreign, now entering our ports by sea in the foreign trade.

Tonnage taxes are practically the only federal charges levied on shipping in American ports, for entry and clearance fees, etc., are too small to be considered. The present rates of tonnage taxes in the United States are lower than those of the principal maritime nations, and very much lower than the rates of some of those nations. Such charges are sometimes called "light dues," and their original purpose here as abroad was to provide from shipping a fund for lighting the coast for the benefit of shipping. Thus, during the year 1903, the light dues collected in the United Kingdom amounted to £548,196, while the expenses of the British lighthouse establishment were £499,404. From light dues, accordingly, the British government met all cost of lighting the coasts of the United Kingdom, and had a surplus of nearly $250,000 a year to add to an accumulated surplus for other years of nearly $2,000,000.

The commission believes that, with entire propriety, a similar general principle may be adopted in the United States. Our receipts from tonnage taxes in 1903 were $885,841, while the expenses of our lighthouse establishment were $4,538,105. The commission does not propose to raise from tonnage taxes an amount sufficient to meet the entire cost of the lighthouse establishment for several reasons:

First. A relatively small part of our lighthouse establishment expenditures is for the rivers and the Great Lakes. Shipping is here in competition with the railroads, and a federal charge ought not to be imposed on vessels from which railroad traffic is necessarily exempt.

Second. To an extent the same is true of the coasting trade. We have reserved our coasting trade to vessels of the United States, and for more than 20 years it has been the policy of the government to pay out of the public funds many of the charges to which American vessels are subject. Accordingly for many years our coasting trade has been exempt from tonnage taxes. The coasting trade of Great Britain, on the other hand, and of some other foreign nations, is not a reserved trade, being open freely or conditionally to the vessels of all nations. Such countries accordingly, with propriety, levy tonnage or light dues on vessels in the coasting trade.

The approximate cost of the proposed legislation in Sections 1 and 2 for the first fiscal year, from July 1, 1905, to June 30, 1906, may be summarized as follows:

Annual retainers to naval volunteers (3,000)	$150,000
Subventions to 44 registered steamships of 203,871 tons at twelve months' rate of $5 per ton	1,019,355
Subventions to 100,000 tons of square-rigged sailing vessels at nine months' rate of $4 per ton	400,000
Subventions to 100,000 tons of square-rigged sailing vessels at six months' rate of $2.50 per ton	250,000
Subventions to 150,000 gross tons of registered schooners at six months' rate of $2.50 per ton	375,000
Subventions to 50,000 tons of deep-sea fishing vessels at nine months' rate of $4 per ton	200,000
Total	$2,394,355

URGENT NEED OF IMMEDIATE RELIEF.

In the midst of a general condition of buoyant prosperity the American merchant marine in over-seas trade alone of our great national industries is, and long has been, depressed and declining. The slight temporary increase of registered tonnage, due in large part to causes growing out of the Spanish war, has now come to an end, and the absolute cessation of shipbuilding for ocean commerce shows that the country is on the verge of a swift and heavy shrinkage in the small registered fleet still left to it—a fleet actually smaller by 100,000 tons than that of 1810. If there is to be remedial legislation it must be prompt and energetic. Delay only increases the cost and intensifies the difficulty of the undertaking.

It may be said without exaggeration that there is not a large ocean shipyard in America, and not an ocean steamship company, except the few mail lines operating under the act of 1891, that is not looking to instant and vigorous remedial legislation by congress as the one hope of its continued existence. Within a few weeks an important shipyard on the Delaware river, after a long and brave fight against adversity, has succumbed and gone into the hands of receivers. This yard has a splendid modern plant, zealous and capable managers, and the prestige of an active career of half a century. The American government and people may well ask themselves this grave question: Where in a few years can they find solvent shipyards to contract with to build their battleships and cruisers unless the complete paralysis now threatening this great industry is speedily arrested by national laws?

If the passage of the legislation proposed by the commission is postponed to the next session of Congress a condition already desperate will have become still more desperate. The time to act is now. The commission has prepared a conservative measure, aiming to achieve its purpose at a minimum cost, fair to all sections and interests, and directed especially to the strengthening of the national defense and the extension of American commerce to new and distant markets. The commission can see no reason why a cautious measure of this kind, making no large immediate draft upon the national revenues, cannot be passed at the present session of Congress.

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The American Merchant Marine.

We wish to call attention to the extracts, in another column of this issue, from the report made to the Senate by Senator Jacob H. Gallinger, Chairman of the Merchant Marine Commission. The condition of our oversea shipping is so deplorable, and the matter so urgent and of such intimate interest to maritime men generally, that it is sincerely to be hoped that something will be done during the present session of Congress to provide relief. The dispatches in the daily papers would seem to indicate that there is a strong probability that this matter may be side-tracked, and allowed to wait another year before anything is done. It seems almost incredible, when no one disputes the urgency and supreme importance of the case, not only from a sentimental, or even from a purely commercial point of view, but from a consideration of the possible requirements for the national defense, that our legislators in Washington can allow such a measure to go by default. It cannot be the cost of operation of the scheme as proposed, at which they balk; for that will be very largely met by the new tonnage tax, which forms an integral part of the proposition. Party considerations certainly cannot dictate any hold-up policy, for both parties are pledged to do what they can for the languishing industry.

This is not the place for any discussion of the subject from a political point of view, even if, as in the present instance, a subject on which the parties are agreed may be said to have a political aspect; but so much of the future of American shipping and shipbuilding depends upon this very thing, so much of the weal or woe of the nation may well be bound up in this, the only neglected branch of its field of activities, that we feel called upon to add what we can to the demand for a prompt and satisfactory solution of the difficulty on the part of Congress.

Were no other argument available, the present maritime plight of Russia, referred to in the report, and one due largely to causes underlying in part our own marine impotency—causes which the operation of the new bill would do much to alleviate, if not altogether to annul—ought to point the moral, and exercise a potent influence in favor of immediate action. But the case does not appeal alone to the fear of national humiliation, remote though that contingency may seem. National pride and a sense of justice are likewise bound up in the matter, for it is not just to ourselves that we continue supinely to allow the greatest carrying trade of the world, a trade which is ours by all the laws of logic, to be taken away from us by other powers, while our own coffers are drained to pay their bills for the service. It has been estimated that the transportation of our foreign commerce involves the expenditure of no less than two hundred millions of dollars per annum. No one will pretend to argue that anything less than fifty percent of this carriage is a fair proportion for us; and this saving of one hundred millions of dollars every year—for, from the point of view of the nation as a whole, it is a saving—would do an immense service in improving conditions among the seafaring and shipbuilding population in this country, would operate to augment their numbers, and place the industry upon that firm basis which characterizes the position of perhaps every other legitimate industry in the United States. Though Abraham Lincoln was arguing on another subject, we cannot but recall, in connection with the question of the payment of these enormous freight bills to foreigners, his remarks about Mrs. Lincoln's cloak: "If she buys it abroad, we get the cloak, and the foreigner gets the money; but if she buys it in this country, we have the cloak, and the money too."

The necessity of the case being conceded, the only question that remains is as to the means to be employed for accomplishing the results desired. The views of the majority are sufficiently well indicated in the extracts to which we have called attention, and provide substantially for a certain subvention, together with provision for enrolling certain parts of the crews of American ships in a corps of naval volunteers, with suitable retainers for the various grades of officers and men. These two features, together with the provision for increased tonnage taxes, constitute the main points of the scheme as proposed by the majority of the Merchant Marine Commission.

The Minority Report, presented to the Senate by Mr. Mallory, gets at the subject in an entirely different way. Arguing that the subvention is nothing more nor less than a new form of the subsidy advocated by the late Senator Hanna and repudiated by Congress some time ago, a plea is made for the establishment of a system of preferential or discriminating duties, and arguments are advanced showing how in the early days of our nation's history such a system was put into effect with splendid results. It is stated that one of the first acts of the first Congress was to establish a tonnage tax of six cents per ton on American vessels and fifty cents on foreign vessels in our ports, and to provide for a rebate of ten percent on the tariff duty charged against goods imported in American vessels. It is further stated that the result of this system was that our mercantile marine advanced by enormous strides, from the carrying of seventeen percent of our imports and thirty percent of our exports in 1789, to ninety-one percent of the imports and eighty-six percent of the exports five years later.

Against this feature of the Minority Report it is argued that a large number of trade conventions with foreign nations must be abrogated, and that we would then face the probability of retaliation against our shipping in foreign ports, and more particularly against our exports, especially food stuffs. It does not appear, however, that there is much danger of this latter form of retaliation, because the only effect would be to increase to the foreign consumer the cost of the necessities of life, and it is hardly probable that any foreign nation would undertake this sort of discrimination. There is one plan of discriminating duties, however, which has been quite prominently advocated, and which involves no possibility of retaliation, and that is a duty discriminating against foreign ships which carry products to the United States from countries other than their own. This provision, of course, would be aimed almost entirely at German, English and Norwegian shipping, and would place in American hands to a large extent the carriage of goods from such nations as have only small merchant marines.

Whatever may be the result of the deliberations of Congress in connection with these two reports, we certainly hope that something will be done immediately, which will have the result at which both sides of the question aim—the resumption by the American flag of the high position which it once occupied in the ocean commerce of the world.

Our Enlarged Page.

We have preached standardization to such an extent that nothing has remained for us but to adopt this policy by enlarging Marine Engineering to "standard size," nine by twelve inches in measurement. A more important reason for the enlargement was the fact that the smaller page did not give us the scope that was necessary in illustrating many articles.

The Screw Propeller.

Of the numerous items making up the design, construction and operation of a steamship of the present day, there is none the importance of which much transcends that of the screw propeller; yet there is certainly none which is less well understood by those who have in charge either its design or its operation. The propeller of the present day is very largely an evolution. This evolution has proceeded, not along strictly scientific lines, but, if we may so state it, along the lines of least resistance. One designer has followed blindly in the footsteps of another, giving vent perhaps to a few of his own ideas in the matter, but being in the main fully as mindful of precedent and subservient to it as would cheer the heart of the most pettifogging lawyer to be found in a day's journey. The inevitable result of such a condition of affairs has been to leave the science of the design of screw propellers, as viewed from the side of practice, in about as chaotic a state as could well be imagined. For fulfilling the same set of conditions two designers will produce two propellers of totally different characteristics, and yet, strangely enough, both will be about equally suited to the task in hand.

The existence of such conditions would appear to indicate that there is no scientific basis for the design of the screw propeller, which conclusion is by no means in accordance with the truth. A certain amount of experimentation has given rise to a knowledge of certain facts connecting the design of the propeller with its operation, and these experiments are being extended at the present time, in the hope of developing a further relation between theory and practice. The theory which has appeared to date, however, has been in general so abstruse as to defy all attempts of the practical man to make satisfactory use of it. Appreciating this condition of affairs, Professor W. F. Durand has prepared for us a series of articles on the subject, in which, as he stated in the opening paragraph of the first of the series, published last month, "an effort will be made to treat the screw propeller in a simple and practical manner with reference to form and structure, delineation on the drawing board, design and adaptation to specific purposes, relation between conditions of operation and results obtained, and features relating to operation under special conditions. The purpose of these articles is to provide a simple answer, in so far as may be possible, to many of the practical questions which are continuously arising in connection with the design, construction, and operation of screw propellers for marine propulsion."

We desire to call especial attention to these articles, which will be continued next month by the question of "Design." Shorn of all the complex mathematical embodiment of the usual treatment of the subject, they should prove of great interest and practical benefit to all who are connected with either the design or the operation of the screw propeller.

ABSTRACTS FROM RULES AND REGULATIONS OF LLOYD'S REGISTER OF SHIPPING.

EDITION OF 1903.

ARRANGED BY HARRISON S. TAFT.

PART II.

25. Riveting.

1. With plates of two thickness. the size of rivet to be governed by the heavier plate.

2. All double and treble riveting should be chain fashion, except for keels, stems, and stern posts, which should be zigzag.

3. Bar Keels, Stems, and Stern Posts to be double riveted. Rivets to be 1-4 inch larger in diameter than otherwise called for, but not to be over 1 1-4 inch diameter. In single screw vessels above 350 feet in length the part of stern frame below boss to be treble riveted to shell.

4. Flat Keel Plates, Floors, Web Frames, Vertical Keels and Keelsons, Rider Plates to be treble riveted throughout.

5. Laps and edges of Bulkheads and Deck Plating to be single riveted. Laps or edge butts of bulkhead plating to floors to be double riveted.

6. All Shell Butts, Deck Stringers, Deck Plate Butts for 1-2 length amidships, Deck Tie Plates, Tank Top Margin and Middle Line Strake of Double Bottom Vessels, and Plate Stringer, to be at least double riveted in all ships. See No. 11 below.

TABLE 12.—THICKNESS OF DOUBLE BUTT STRAPS FOR SHELL PLATING, SHEER STRAKE AND DECK STRINGERS.

Thickness of Plate in 20th	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Straps for cks Rivets in 20th......	7	8	8	9	10	10	11	12	12	13	14	14	15	15
Straps on opposite Side in 20th...	6	6	7	7	8	9	9	10	11	11	12	13	13	14

TABLE 13.—BUTT STRAPS AND RIVETING SCHEDULE FOR SHELL PLATING AND DECK STRINGERS.

Second Numbers.	Not over 8,000.	[1]Over 8,000. Not over 13,000.	[1] Over 13,000 Not over 16 000.	[1] Over 16,000. Not over 20,000.	[2] Over 20,000. Not over 24,000.	[2] Over 24,000. Not over 28,000.	[2] Over 28,000.
Butt straps of :							
Sheer strake............	D R $+\frac{1}{20}''$	T R $+\frac{2}{20}''-\frac{1}{2}$ L	T R $+\frac{2}{20}''-\frac{1}{2}$ L	T R $+\frac{2}{20}''-\frac{1}{2}$ L	T R $+\frac{3}{20}''-\frac{1}{2}$ L	T R $-\frac{3}{4}$ L $+\frac{4}{20}''-\frac{1}{2}$ L	T R T $+\frac{4}{20}''-\frac{3}{4}$ L
First bilge strake........	D R T $+\frac{1}{20}''-\frac{1}{2}$ L	T R $+\frac{2}{20}''-\frac{1}{2}$ L	T R $+\frac{2}{20}''-\frac{1}{2}$ L	T R $+\frac{2}{20}''-\frac{1}{2}$ L	T R $+\frac{3}{20}''-\frac{1}{2}$ L	T R $-\frac{3}{4}$ L $+\frac{4}{20}''-\frac{1}{2}$ L	T R T $+\frac{4}{20}''-\frac{3}{4}$ L
Second " "	D R	T R $+\frac{2}{20}''-\frac{1}{2}$ L	T R $+\frac{2}{20}''-\frac{1}{2}$ L	T R $+\frac{2}{20}''-\frac{1}{2}$ L	T R $+\frac{3}{20}''-\frac{1}{2}$ L	T R $-\frac{3}{4}$ L $+\frac{4}{20}''-\frac{1}{2}$ L	T R T $+\frac{4}{20}''-\frac{3}{4}$ L
Third " "	D R	D R	T R $+\frac{2}{20}''-\frac{1}{2}$ L	T R $+\frac{2}{20}''-\frac{1}{2}$ L	T R $+\frac{3}{20}''-\frac{1}{2}$ L	T R $-\frac{3}{4}$ L $+\frac{4}{20}''-\frac{1}{2}$ L	T R T $+\frac{4}{20}''-\frac{3}{4}$ L
Other outside strakes...	D R	D R	D R	T R $+\frac{2}{20}''-\frac{1}{2}$ L	T R $+\frac{3}{20}''-\frac{1}{2}$ L	T R $-\frac{3}{4}$ L $+\frac{4}{20}''-\frac{1}{2}$ L	T R T $+\frac{4}{20}''-\frac{3}{4}$ L
" inside "	D R	D R	D R	D R	T R $+\frac{3}{20}''-\frac{1}{2}$ L	T R $-\frac{3}{4}$ L $+\frac{4}{20}''-\frac{1}{2}$ L	T R T $+\frac{4}{20}''-\frac{3}{4}$ L
U D stringer............	D R $+\frac{1}{20}''$	T R $+\frac{2}{20}''-\frac{1}{2}$ L	T R $+\frac{2}{20}''-\frac{1}{2}$ L	T R $+\frac{2}{20}''-\frac{1}{2}$ L	T R Dbl $-\frac{1}{2}$ L	T R $-\frac{3}{4}$ L + Dbl $-\frac{1}{2}$ L	T R T + Dbl $-\frac{1}{2}$ L
M D "	....	....	....	....	T R $+\frac{3}{20}''-\frac{1}{2}$ L	T R $-\frac{3}{4}$ L $+\frac{4}{20}''-\frac{1}{2}$ L	T R T $+\frac{4}{20}''-\frac{3}{4}$ L
End straps..............	D R	D R	D R	D R	D R $+\frac{2}{20}''$	D R $+\frac{2}{20}''$	T R $+\frac{2}{20}''$
Wide shell plates.......	T R $+\frac{1}{20}''$	T R $+\frac{1}{20}''$	T R $+\frac{1}{20}''$	T R $+\frac{1}{20}''$	T R $+\frac{1}{20}''$	T R $+\frac{4}{20}''$	T R $+\frac{4}{20}''$

Flat keel plates are to be triple riveted throughout.
[1] Triple riveted butts may omit alternate rivets in back row.
[2] Triple riveted butts to have back row of rivet spaced 5 to 5¼ diameters. All triple riveted lapped butts to have three complete rows.
D R = double riveted ; T R = triple riveted ; T R T = triple riveted throughout , D R T = double riveted throughout.
Plus sign (+) means *with*. Minus sign (−) means *for*.
Examples: T R $+\frac{2}{20}''-\frac{1}{2}$ L means: triple-riveted butts with butt straps $\frac{2}{20}$ of an inch heavier than plating for ½ length amidships.
T R $-\frac{3}{4}$ L $+\frac{4}{20}''-\frac{1}{2}$ L means: triple-riveted butts for ¾ length amidships with butt straps $\frac{4}{20}$ of an inch heavier for ½ length amidships.

7. Longitudinal Laps of Shell Plating to be single riveted for bottom plating, from keel to upper turn of bilge, of less than 7-20 inch thick, and for side plating, from upper turn of bilge to gunwale bars, of less than 9-20 inch thickness. Otherwise, laps are to be double riveted. Lower edge of sheer strakes to be double riveted in all cases. The style of midship riveting to be carried to ends of ship. When length of ship is 480 feet or above, the longitudinal laps are to be treble riveted for 1-3 depth of vessel in fore-aft part of ship for a distance of 1-4 vessel length. When of 450 feet to 480 feet long to have said treble riveting as called for.

8. Lap Butts of Shell Plating for vessels whose second number is under 16,000, to be treble riveted for 1-2 length amidship and double riveted at ends. When said number is or above 16,000 said butts to be treble riveted throughout; with three complete rows in all cases.

9. Shell Straps and Deck Stringers.

a. The boss plate butts to be treble riveted when second number is 18,700 or above, as per specified.

b. Outside shell strakes over 40 inches and not exceeding 46 inches in width; inside shell strakes 48 inches and not over 54 inches in width, to have treble riveted butts.

10. Single riveted Shell Seams to have one frame rivet through landing edge at each frame. Double riveted seams to have one rivet only, except in cases of joggling, when two rivets must be used. Treble riveted seams to have two such rivets (the middle one being omitted.)

11. Double Bottom.

a. Butts and edges of middle strake plating to be in all cases double riveted. In engine and boiler room all butts and edges of plating to be double riveted. Butts of side girders and margin plates to be double riveted. When second number is under 21,000 the center line girder butts are to have double straps double riveted. When said number is over 21,000 the butt of center, side girders, and margin plates to be triple riveted with alternate rivet in back now left out.

b. When second number is 20,000 and under 30,000, all butts of inner bottom plating to be double riveted for 1-2 length amidship.

c. When said number is 30,000 and under 38,000, all butts of inner bottom plating and an additional strake edge on each side of middle line strake are to be double riveted throughout.

d. When said number is 38,000 and under 51,000, the remaining edges to be double riveted for 1-2 length amidship.

e. When longitudinals are worked on top of floors, all butts (except of margin plate) and edges of all plating may be single riveted.

12. *a.* LOWER MASTS. Seams to be double riveted. In masts of less than 84-foot length they may be single riveted if angle stiffeners are used. Butts below partners to be double, those above triple riveted. Seams of steamers' masts with fore-aft sails, or of masts used for auxiliary purposes, may be single riveted throughout.

b. TOPMASTS AND YARDS to have single riveted seams and treble riveted butts.

c. BOWSPRITS to have double riveted butts inside of wedging, trbele riveted outside of wedging.

13. AWING DECK stringers and side plating to have double riveted butts.

14. RUDDER RIVETS to equal those in upper edge of garboards amidships for side plate rudders, and to those of shell to stern frame for single plate rudders.

15. DOUBLING PLATES should be riveted up in the center of plate before at edges.

16. There should be at least four rivets in each flange of stringer shell clips when frame spacing is less than 29 inches; otherwise 5 rivets, up to a 32-inch frame spacing.

17. When fore-aft flange of frame does not exceed 3 inches, shell rivets to frames should not exceed 7-8 inch diameter; when said flange is 3 1-2 inches, not over 1-inch rivets are to be used.

18. Angle bosom pieces to take 3 rivets on each side of butts. Those for reverse bars may have but 2 rivets, except for a butt on center line, where 3 rivets must be used.

19. Floor clips to have 3 rivets to floors.

20. Deep frame angles to have single riveted lap to frame.

21. Side stringer plate brackets to have two rows of rivets to said stringer at bulkheads.

22. Shell butts with a single treble riveted strap, when second number is 20,000 and under can have alternate rivets of back row left out. When above 20,000, said rivets may be spaced 5 to 5 1-4 inches apart. All lapped butts to have 3 complete rows.

23. COUNTERSUNK. Depth to equal thickness of plate when less than 14-20 inch, but 9-10 of said thickness when plate is or above 14-20 inch thick.

26. Double Bottoms.

1. When frames are cut at margin plates the margin plate bottom and top frame brackets to be worked at every frame.

2. LONGITUDINAL GIRDERS PLACES ON TOP OF THE FLOORS should not exceed 3 feet apart. They are to have a continuous top and bottom angle. Margin plated top frame brackets to be worked at every frame. When reverse bars are cut short doubling pieces should be worked to frames in way of margin plate.

TABLE 14.—DOUBLING OF CLIPS ON MARGIN PLATE TOP FRAME BRACKETS, AND SPACING OF GUSSET PLATES.

Second Number.	Extent of Double Clips on Margin Brackets.	Gusset Plates.
*20,000 under 40,000....	½ L amid.	....
30,000 " 40,000....	⅝ L "	Every 4th frame.
40,000 " 50,000....	†¾ L "	" 3d "
50,000 and up..........	Throughout.	" 2d "

*Deep or web frame vessels only.
† Measured from collision bulkhead.
Single clips on outside of margin plate should be worked opposite to floor or bracket clips on underside of margin plate.

3. CELLULAR BOTTOMS WITH CONTINUOUS LONGITUDINALS.

a. When second number is or under 11,000, triangular bracket plates are to be fitted on each side of longitudinals at top and bottom on alternate frames fore-aft of machinery space. When said number is 11,000, solid man-hole floor plates are to be fitted to alternate frames throughout double bottom.

b. Center keelson brackets are to be fitted to the intermediate frames on all ships with flat keels, and in vessels with hanging keels when second number is 18,000 or above. When second number is 38,000 and under 51,000, said brackets and those at margin plate to be wide enough on top to take 3 rivets of an intermediate reverse angle for 3-5 length. Floor plates should be secured to center vertical keelson with single clips unless second number is 24,000 or above, when they should be doubled for 1-2 length amidship. Inside and outside margin plate frame brackets to be fitted to every frame.

c. Floors should be fitted on every frame between collision bulkhead and the 3-5 length of vessel amidship.

4. CELLULAR BOTTOMS WITH SOLID CONTINUOUS FLOORS.

a. The floors are to be worked in one piece from center line to margin plate and placed on every frame, with double clips to center vertical keelson for 1-2 length amidship when second number is 24,000 or above. Intercostal longitudinal girder to be worked at about 1-2 distance from center line to margin plate, and they are to be well clipped to shell and inner bottom.

b. When the vessel's breadth from margin plate to margin plate is 34 feet and not over 44 feet, two intercostal longitudinal girders must be used.

5. Provisions should be made for a thorough ventilation of inner bottom spaces by cutting liners short or otherwise.

6. Solid man-hole floors are to be fitted to every frame in engine room and to alternate frames in boiler rooms with double top angles and clips throughout.

7. When double bottom is worked throughout boiler and engine spaces a well should be provided at aftermost frame space in engine room.

8. The inner bottom plating to be worked fore-aft and to be covered with at least 2 1-2 inches of wood.

9. Intermediate reverse stiffening bars should be worked to inner bottom plating unless longitudinals are fitted closer than specified with solid floors fitted to alternate frames.

10. Double bottom ships built under Nos. 2 or 4 can have shell plating in way of same (except keel and garboards) reduced by 1-20 inch when said plating is 11-20 inch or above.

11. If flange bracket plates are used they should be 1-20th heavier than otherwise.

27. Hatch Ways and Deck Openings.

1. Minimum heights of hatch way coamings above weather decks should be as follows:

On shelter, bridge, or awning decks, 18 inches.

On upper, spar, or raised quarter decks, 24 inches.

On upper decks in wells of well-deck vessels, 30 inches.

2. Hatch coaming deck angle to extend 1-2 inch above wood deck. Alternate spaced half beams to be secured to coaming plate with double clip; every frame spaced beams with single clip. Three-rivet connection to coaming plates for half beams of 7 1-2 to 9 inches in depth; 4 rivets for depth of 10 to 12 inches.

3. Web beams to have double angles on top and bottom and to extend to lower edge of fore-aft coaming plates. To equal the thickness of end coamings. Center depth of web plate for shallow coamings on middle deck to be 1 1-4 end depth and ends are to extend to lower edge of coaming.

4. Hatch covers should be from 2 1-2 to 3 inches thick, with a 1 3-4-inch bearing at edges. Cleats for holding down tarpaulins to be spaced not more than 2 feet apart.

5. All coaming plates to extend to lower edge of beams at end of hatches.

TABLE 15.—HATCH COAMINGS.

Weather Deck.			Middle and Lower Decks.			
Weight of Coaming Plates.			Depth and Weight of Coaming Plates.			
Hatch Length in Ft.	Side.	End.	Hatch Length in Ft.	[1] Depth.	[2] Side.	End.
Under 12	$\frac{7}{20}$"	$\frac{7}{20}$"	10 under 14	16"	....	....
12 " 16	$\frac{7}{20}$"	$\frac{7}{20}$"	14 " 18	18"	....	....
16 to 24	$\frac{7}{20}$"	$\frac{7}{20}$"	18 to 24	20"		....

[1] Depth from under side of carling to top of coaming.
[2] $\frac{1}{20}$" thicker than for an upper deck hatch side coaming of same length.

TABLE 16.—HATCH BEAMS.

Hatch Beams for Deck Hatches of 12' and under 16' in Length.		Number and size of Fore-Afters Resting Upon Web Beams.			
				[1] Bulb Plate.	
Width in Feet.	Number of Beams.	Hatch Width.	No.	Center.	Side.
Under 12'	One 8" beam	6' under 8'	1	7" × $\frac{7}{20}$"	....
12' " 16'	" 9" "	8' " 10'	1	8" × $\frac{8}{20}$"	....
Hatch beams for deck hatches, 16' to 20' in length		10' " 12'	3	8" × $\frac{8}{20}$"	5" × $\frac{5}{20}$"
Length in Feet.	Number of Beams.	12' " 14'	3	9" × $\frac{9}{20}$"	6" × $\frac{6}{20}$"
16' to 20'	One web plate	14' " 16'	3	10" × $\frac{10}{20}$"	7" × $\frac{7}{20}$"
20' " 24'	Two " plates	.. ..	..	....	....

[1] Wooden ones may be used if of equal strength.

28. Deck Houses. Boiler and Engine Casings.

1. Engine or boiler room skylights which are located on a poop or bridge house deck, should have coamings at least 2 feet high.

2. Engine and boiler deck houses on a weather deck are to have coamings at least 18 inches above said deck, with steel casing to about 7 feet above the deck. Thickness of plating to equal that of side plating of a poop, with coaming plate 1-16 inch heavier than for trunk bulkheads. In awning-deck vessels said steel casing need not exceed 4 1-2 feet above deck if a skylight is worked on top with iron covers and a 9-inch or more coaming. Said deck house and between decks casings to have stiffeners spaced 30 inches apart equal to reverse bars. Doors in said deck houses and said casings to have lower edge 18 inches above deck.

29. Masts, Yards, Bowsprits and Chain Plates.

1. All masts of 75 feet or more in length (from cap to top of keelson) to be built of 3 strakes, and plates should be doubled in way of partners. Three lines of stiffeners extending entire length of mast are to be worked on inside when masts are 84 feet or above from cap to top of keelson. Diameter of masts at partners is to be 1-3 of length as specified above. Diameter at heel to be 3-4 of diameter at partners + 1-16 inch. Diameter of head to be 5-8 diameter at partners + 1-16 inch.

2. BOWSPRITS over 28 inches in diameter to have a vertical web plate from within the wedging to gammoning, with single angle bar connection to plating, and with two additional angle bar stiffeners. When diameter is 28 inches or below, to have angle bar at center of plate for whole length of sprit. Plates to be doubled at wedging.

3. TOPMASTS to be doubled in way of lower mast cap. When 38 feet in length and under 46 feet, to have two angle stiffeners 3 inches by 2 1-2 inches by 6-16 inch on fore and aft parts of masts. When length is 46 feet and under 66-foot angles to be 3 1-2 inches by 3 1-2 inches by 6-16 inch. Diameter at lower cap, sheave hole, and topmast cap to be not less than that of yards at the places.

4. YARDS to be doubled at center, extending beyond truss hoops.

5. STEAMERS. Lower and upper masts and bowsprit fitted for auxiliary purposes only, may be 1-8 less in diameter than otherwise. When said masts are to carry fore-aft sails only, they may be 1-5 less in diameter than otherwise.

6. Chain plates to be in proportion to vessel's size and be well secured to sheer strake when possible.

30. Sluice Valves, Ventilators, and Freeing Ports.

1. Ventilator coamings should stand at least 3 feet above a weather deck. When under 12 inches in diameter to be of 1-4-inch plate; when of 12 inches and under 15 inches diameter 5-16-inch plate; when of 15 inches to 24 inches diameter 3-8-inch plate.

2. Doubling plates to be fitted under all sounding pipes.

3. Sluice or gate valves must not be fitted to forward collision bulkhead. If fitted to other water-tight bulkheads they must at all times be accessible, with rods extending above load water line.

When aft peak is used as a ballast tank no sluice valve or cock is to be fitted to aft collision bulkhead. But if used otherwise and no pump is connected to it, a sluice valve may be placed on said bulkhead.

4. Soil pipes discharging below load water line must have an iron pipe for some distance above load water line from opening. If the upper part of the pipe be of lead it must be properly protected with either zinc or iron.

5. All head and stern pumps must be fitted with sea-cocks to the outside plating and shall always be accessible.

TABLE 17.—AREA OF FREEING PORTS.

Length of well bulwarks in feet. . . .	30	35	40	45	50	55	60
Total area, each side, in square feet...	9.5	10	10.5	11	11.5	12	12.5

65 feet and above: 1 square foot for each 5 feet of length. Ports to have yellow metal pins in hinges and are to swing outboard.

31. Wood Decking, etc.

1. When laid on an upper steel deck to be 3 inches thick for pine and 2 1-2 inches for teak. When laid on a middle steel deck 2 1-2 inches thick.

2. When a 4-inch deck is worn to 3 inches, a 3 1-2-inch to 2 3-4 inches, and a 3-inch to 2 1-2 inches, they should be renewed.

3. Cargo battens to be worked in holds and all enclosed cargo spaces.

4. Deck planks 6 inches or less in width to have single fastenings; when over 6 inches double fastenings. Upper deck to be fastened with galvanized screw bolts, with nuts at under side of the beam flange and tie plates. Deck plans to be scored over diagonal tie plates.

32. Steering Gears and Rudders.

1. Diameter of steamer's rudder to be determined by the formula:

$$d = \frac{1}{32}\sqrt[3]{D \times b\,(2B - b)S^2}.$$

Where D = draft in feet, B = greatest distance in inches from center of pintles to back of rudder; b = greatest breadth of rudder in inches, and S speed in knots.

2. Diameter of chains in inches is found as follows:

$$d = .38\sqrt{\frac{D^3}{r}}.$$

Where D = diameter of rudder head in inches, and r = radius of quadrant in inches.

3. Rods to be 1-4 larger in diameter than chains as above.

4. Diameter of sheaves to be at least 16 diameters of chain; pins are to be twice diameter of chain.

5. Steering engine stops should be set at a slightly less angle than rudder stop. Rudder side plates to equal lower part of bulkhead plating.

6. Springs to be attached to all steering gear of steamers.

7. Rudder pintles to be spaced 4 to 5 1-2 feet apart with top pintle as near the rudder's head as possible.

8. Steamers above 250 feet in length to have both steam and hand steering gears.

9. Spare tiller and gear to be provided with ships that do not have two independent steering gears.

10. Cast steel rudders, quadrants, and tillers of ordinary design to be dropped onto hard ground from a height of 7 to 10 feet and then to be well hammered with at least a 7-pound hammer.

33. Boat and Anchor Davits.

Diameter of boat davits in inches to be 1-5 length of boat in feet when of usual proportions. Otherwise:

$$\sqrt[3]{\frac{L \times B \times D}{40}\left(\frac{H}{3} + S\right)}.$$

Where L, B, D, are the boat's dimensions, H = heights of davit above top support, and S = spread, all expressed in feet.

TABLE 18.—DIAMETER OF ANCHOR DAVITS.

	Spread in Feet.						
Weight.	9	10	11	12	13	14	15
2,240	6″	6¼″	6½″	6¾″	6¾″	7″	7¼″
2,800	6½	6¾	7	7¼	7¼	7½	7¾
3,360	7	7¼	7½	7¾	7¾	8	8¼
3,920	7¼	7½	7¾	8	8	8¼	8½
4,480	7½	7¾	8	8¼	8½	8¾	9
5,040	8	8¼	8⅛	8¾	9	9¼	9½
5,600	8¼	8½	8¾	9	9¼	9½	9¾
6,160	8½	8¾	9	9¼	9½	9¾	10
6.720	8¾	9	9¼	9½	9¾	10	10¼

TIE RODS.

Diameter of main post at deck	6″	6½″	7″	7½″	8″	8½″	9″	9½″	10″	10½″
" " tie rod	1¾	1⅞	2	2⅛	2¼	2⅜	2½	2⅝	2¾	2⅞
" " jib (middle)	3	3¼	3½	3¾	4	4¼	4½	4¾	5	5¼

With two tie rods, each to be three-quarters diameter of single rods.

When anchor chains are worn to four-fifths of their original cross-section area, said secion should be renewed.

34. Three=Deck Vessels.

1. Three-deck vessels to be at least 17 feet to middle deck with two or more complete decks and calked and with hold beams or web framing, etc.

2. Sheer strake to be at upper deck gunwale and middle deck strake to be an outside one. Sheer strake, upper and middle deck stringers, and three bilge strakes to be treble riveted for 1-2 length. (See Table 13.)

35. Spar=Deck Vessels.

1. Said vessels to have three tiers of deck beams and be not less than 17 feet in depth to main deck. Being of a lighter construction than three-deckers, they are to have two sheer strakes; one at spar deck the other at middle deck. Both sheer strakes, spar, and middle deck stringers, and three bilge strakes to be treble riveted for 1-2 length. Main deck sheer strake to have its lower edge not more than 1-2 its depth below main deck stringer. Wood decking 3 1-2 inches thick to be fitted on main deck.

36. Awning Deck Vessels.

1. This class consists of those having a light upper structure over the main deck proper, with rounded gunwale, beams are to lap frame 18 inches. Awning deck beams to be on alternate frames. Engine and boiler enclosures as for ordinary weather deck.

37. Poop, Forecastle, Bridge=House Vessels.

1. In way of these superstructures a reduction of 1-4 from the dimensions, which would be necessary if the vessel was flush deck, will be allowed in outside plating stringer and tie plates upon beams, angle bars, or stringer plates and flat of deck.

2. Beams of these decks to be spaced on alternate frames with an 18-inch lap to frames if rounded form of gunwale is used. Side plating in way of poop, forecastle and bridge houses above sheer strake need not exceed that for awning vessels, and have double riveted butts.

3. When poop exceeds 1-4 vessel's length the sheer strake is to be worked double and upper deck stringer increased in way of break for 20 to 30 feet.

4. When combined length of a poop and bridge-house deck, or of a raised quarter deck and bridge-house deck exceeds 2-5 length of vessel, and second number is or above 15,000, the sheer strake is to be doubled for 1-2 length amidships. In vessels whose bridge house is not less than 2-5 length the aforesaid doubling may be dispensed with if other specified strengthening is used. Bulwarks at ends of the bridge house to be increased in weight.

38. Raised Quarter Decks and Sunken Forecastles.

1. Number and arrangement of hold beams, beam stringers, and hold stringers in way of a raised quarter deck, and the height of reverse bars on frames must be in accordance with the rules for the increased depth of vessel.

2. Main sheer strakes to be doubled at break unless raised quarter deck connects with bridge house, in which case side plating of the raised quarter deck is to be doubled. If the side plating of raised quarter deck is not doubled it must be increased and sheer strake doubled at said point. Bulwark plate of raised quarter deck adjoining the bridge side plating to be increased in weight; the sheer strakes to be doubled at front of bridge. Butts of side plating of raised quarter deck, of main sheer strake and of strake next below, to be treble riveted at break with heavier straps. Main deck stringer to extend abaft of brake about seven frame spaces and the raised quarter deck stringer forward about four frame spaces. Bridge stringer also to extend aft of brake. Raised quarter deck to be connected to deck bridge house with double angles.

3. *a.* With vessels of extreme proportions requiring a steel deck to be worked on main deck said deck plating should scarph raised quarter deck for two to five frame spaces and have four to five diaphram plates with double clip connections to decks and brake bulkhead, with an angle on aft face, with doubling of raised quarter deck side plate at said point for 18 to 20 feet in length; web plates of at least 15 inches wide are to be fitted to forward side of brake bulkhead in way of diaphragm plates, with brackets to decks at top and bottom.

b. When second number is 24,000 and under 26,000, scarphs to cover four frame spaces with 18-inch webs on bulkhead, with doubling of raised quarter deck side plates from 1-4 length from stern to 8 feet beyond brake bulkhead. When said number is or over 26,000, to have a five-frame scarph with web and doubling of sides as herein stated.

c. When second number is over 20,000 or ratio of length to depth exceeds 13, the brake bulkhead to be at least four frame spaces abaft aft end of engine room opening.

4. When vessels are of ordinary proportions as not to require the above scarphing of main and raised quarter decks, four or five bracket knees should be fitted on both sides of break bulkhead.

5. When combined length of a poop and bridge house, or of a raised quarter deck and bridge house exceeds 2-5 vessel's length, and second number is or above 15,000, the sheer strake is to be doubled for 1-2 length amidships.

6. When depth to top of a raised quarter deck beam is 24 feet or over and lower deck hatches are not framed, a web frame must be worked abreast of hatches, extending from floor to upper deck.

39. Rivet Spacing, Lloyd's Register.

1. Edge laps, center to center of rows, not less than	1 1-2 diameters.
2. Butt straps, " " " " " " " "	2 "
3. Butt laps, " " " " " " " "	2 1-2 "
4. *a.* Butts of shell plating; butts of upper spar and middle deck stringers, and of stringers of bridge decks exceeding 1-3 length of vessel amidships (except quadruple riveted butt laps)	3 1-2 "
b. With single butt strap treble riveted, when second number is under 20,000, alternate rivet in back row may be left out. When second number is 20,000 or over, back row to be spaced	5 to 5 1-4 "
(All lapped butts to have three complete rows.)	
5. Quadruple riveted butt laps; butts of deck plating; of margin plates; of girders; of lower deck and hold stringers; of tie plates; of floor plates; of stringer plates on other deck erections; butts and edges of inner bottom plating; edges of shell plating (forward and aft) for a frame spacing of 26 inches or over; landing edges of plating in flat of bottom before 3-5 length in vessels of full form forward	4 "
6. Edges of shell plating, forward and aft; gunwale bars; margin plate angles; edges and butts of bulkhead plating	4 1-2 "
7. Keelson angles; water-tight bulkhead frames; butts and edges of mast plates; deck plating to beams where single flange beams are fitted to alternate frames; rudder plates; stems; stern posts; keels	5 "
8. Frame shell rivets in flat of bottom plating before 3-5 length in vessels of full form forward	5 1-2 "
9. Frame shell rivets in deep ballast tanks above inner bottom, and in fore-aft peak's water ballast tanks. Frame shell rivets for frame spacing of 26 inches or over	6 "
10. Frames; reverse frames; floor keelsons; beams angles; deck and hold stringer angles; face bars on web frames and side stringers; bulkhead stiffeners; longitudinal angles on continuous girders; vertical angles connecting floors and girders; deck plating to beams, except where single flange beams are fitted to alternate frames	7 "
11. Edge of deck plating	4 to 4 1-2 "
12. Rivets are not to be placed nearer edge of plates or angles than their own diameter.	

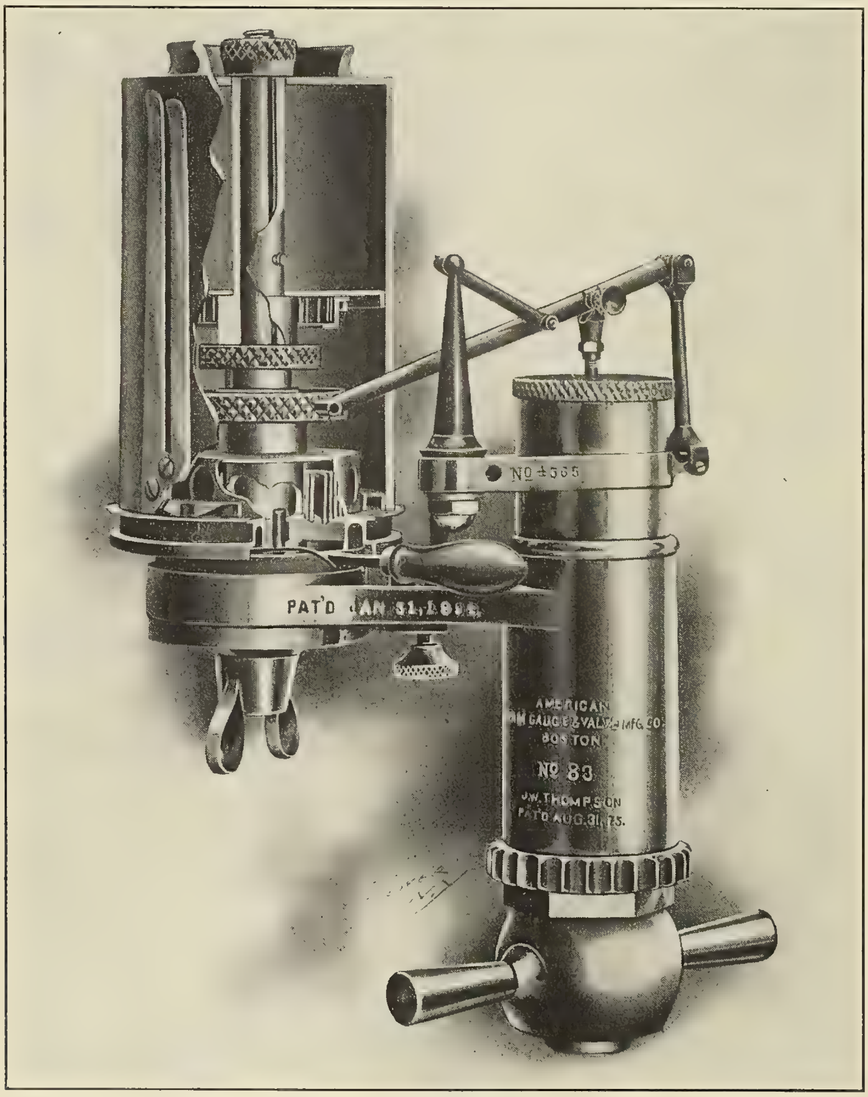
TABLE 19.—LLOYD'S REGISTER. WIDTH OF BUTT LAPS AND BUTT STRAPS. SPACING OF RIVETS.

	Weight of Plate. Lbs.	Diameter.	10–12	12–20	20–26	26–34	34–40
	Diameter of Rivet. Inches.	Pitch.	5/8	3/4	7/8	1	1 1/8
Widths of:	Single riveted butt lap	...	...	...	...	...	...
	Double " " "	...	4 1/4	5	6	...	...
	Triple " " "	...	...	7 1/2	9	10 1/2	12
	Quadruple " " "	...	...	...	12	14	16
	Double " " strap	...	8	9 3/4	11 1/4	...	...
	Treble " " "	...	...	14 1/4	16 3/4	19	21 1/2
	Single " seam lap	...	2 1/4	2 1/2	3	...	...
	Double " " "	6	3 3/4	4 1/2	5 1/4	6	6 3/4
	Triple " " "	...	...	...	7 1/2	8 1/2	9 1/2
	Single " edge strip	...	...	...	...	...	...
	Double " " "	...	...	...	...	...	...
Spacing of rivets.	1.—ϕ of rivet from edge of plate. Edge riveting: ϕ to ϕ of rows	1 1/2	15/16	1 1/8	1 5/16	1 1/2	1 11/16
	2.—Butt straps. ϕ to ϕ of rows	2	1 1/4	1 1/2	1 3/4	2	2 1/4
	3.— " laps. ϕ to ϕ of rows	2 1/2	1 9/16	1 7/8	2 3/16	2 1/2	2 13/16
	4.—	3	2	2 1/4	2 5/8	3	3 3/8
	5.—Shell butts; upper, middle, spar-deck stringers, except quadruple riveted butt laps	3 1/2	2 1/4	2 5/8	3 1/8	3 1/2	4
	6.—Quadruple riveted butt laps; deck and inner bottom plating; hold stringers; floor, tie, and margin plates	4	2 1/2	3	3 1/2	4	4 1/2
	7.—Edge af deck plating	4 to 4 1/2	...	...	...	...	...
	8.—Long. seams of shell plate forward and aft; gunwale bars; margin plate angles; bulkhead butts and seams	4 1/2	2 3/4	3 3/8	4	4 1/2	5 1/16
	9.—Keelson bars; W. T. frames; mast butts and edges; deck plating to beams with single flange; rudder plates; stem, stern post, bar keel	5	3 1/8	3 3/4	4 3/8	5	5 5/8
	10.—Frame shell rivets in flat of bottom before 3/5 L in vessels of full force forward	5 1/2	3 7/16	4 1/8	4 13/16	5 1/2	6 3/16
	11.—Shell-frame rivets for frame spacing of 26″ or over	6	3 3/4	4 1/2	5 1/4	6	6 3/4
	12.—Frames; reverse bars; floors; keelsons; stringer angles; bulkhead stiffeners; floor and keelson clips; continuous girder angles; deck plate to beams with double flange	7	4 1/2	5 1/4	6 1/4	7	7 7/8

ENGINEERING SPECIALTIES.

Improved Detent Motion for Indicators.

Ever since the introduction of the steam engine indicator, for the purpose of measuring the power of engines, it has been recognized that a very serious limitation consisted in the fact that the indicator was hardly applicable to fast running engines. This was due mainly to the great difficulty in getting the paper drum connected with the speed-reducing device, and again disconnected for the purpose of removing the cards. This defect has been remedied by what is known as a *detent* motion, applied to the new American Thompson indicator, manufactured by the American Steam Gauge and Valve Manufacturing Company, of Boston, Mass. In the new form the drum carriage, after it is once connected with the reducing motion, need not be disconnected until desired, as means is provided for stopping the motion of the drum without making any change in the connection with the reducing device.



INDICATOR WITH DETENT MOTION DEVICE.

We show herewith an illustration of one of these indicators fitted with the detent motion, and would call attention to the handle shown in the middle of the engraving. By moving this handle, or lever, in the direction traveled by the paper drum, until the drum releases itself, the connection between the drum and the motion of the reducing gear is broken, and a new card may be placed on the drum, or the old one taken off, with great ease. To reconnect the drum with the reducing motion, all that is necessary is to turn the drum by means of the milled rim on the top until the catch draws it into play again. That this form of indicator will be a great boon to those who are indicating engines of either the marine or the locomotive type, and, indeed, of high-speed engines generally, needs no emphasis.

Roller Bushings.—One notable departure in the outfit of the five lightships building at the yards of the New York Shipbuilding Company, Camden, N. J., has been in the roller bushing supplied in their outfit of tackles. It has been the custom of the United States government for some 12 or 14 years past to insist upon the use of a bushing manufactured expressly for its own use at a considerable expense. In equipping these ships, however, a bushing such as is used in the merchant marine has been substituted, and it is believed by many that the innovation is not only in the interests of economy, but efficiency as well.

New Boiler-Scale Destroyer.

The attention of interested persons is being directed to a new patent water softener, exploited by the Hull Boiler-Fluid Company, of Cumberland street, Hull. It is described as a fluid boiler composition which will "soften" any kind of hard water and greatly prolong the life of steam boilers. It prevents scaling, and in the case of boilers that have already become foul it will gradually disintegrate and remove old scale and prevent priming. Samples of old scale are exhibited which the fluid is credited with having broken up. In some cases, it is said, the scale was a hard, cement-like formation nearly an inch thick. After a use of the scale destroyer for about three months it is claimed the deposit in the boilers was in the form of a fine, smooth powder or dust, which could be washed away by a hose pipe and water, instead of an incrustation that had to be laboriously chipped off with hammer and chisel.

The composition is described as of a purely vegetable nature, no chemicals being used in any way in its manufacture, and there is said to be nothing in it to injure the plates or fittings of the boilers, whether of iron, copper, brass, or other metal. In order to thoroughly test its behavior in this respect, a large steam boiler was filled with the crude undiluted fluid and run at 60 pounds pressure for three weeks. It was then examined by a boiler inspector and an insurance company's man and reported to be in perfect condition. It is also claimed that where this softener is employed the steam may be used for the most delicate operations of any manufactory without the slightest ill effect, and that a large number of representative firms have tried it under actual working conditions, and have written, speaking very highly of its effect. It is now under trial at sea for use in marine boilers with salt water.—*Daily Consular Report.*

TECHNICAL PUBLICATIONS.

Naval Fleets in 1904. By Commandant de Balincourt (French Navy). Size 6 by 4 1-2 inches. Pp. 845 + vi. + 34, with about 400 outline figures of ships. Paris: Berger, Levrault & Company. Price presumably 6 francs, as last year.

The absorbing struggle between Japan and Russia has given rise to the manifestation on the part of the public of a great amount of interest in naval matters. So clearly has it been shown that without the command of the sea, assured to Japan by the first two blows of the war, she could have accomplished nothing in Manchuria, by reason of her consequent inability to land troops for the operations there, that information on the subject in question is eagerly sought on all sides. The present work is a continuation of similar volumes of previous years, this being the fourth in the series. It presents, in very condensed form, a vast amount of information about the ships which form the *materiél* of the various navies of other maritime powers. The arrangement of this subject matter is excellent; on each left-hand page is given a cut showing the outline or outboard profile of the ship to be described, as well as one or more sketch deck plans. These show clearly the general arrangement of the armor protection, the positions of the guns, and the general appearance of the vessel. On the opposite, or right-hand, page are given the data relating to dimensions, displacement, power, speed, battery, armor, fuel supply, and various other items making up the characteristics of the ship, or affecting her fighting value. To this are added, in many cases, notes and comments on the vessel's condition, and such brief criticism as the case seems to require, with occasionally a casual comparison with some other similar ship.

Under the several navies the ships are arranged in approximate order of importance and date, while the various countries are arranged in alphabetical order, each navy being accorded a short preface, outlining the present general tendency of design and construction. As a reference book, which is the primary intention, this little work seems admirably adapted for its purpose; and for those who are conversant with the French language it is full of valuable information, which appears to be correct, and to have been collaborated with great industry and care. Even without a reading knowledge of French, a reader might readily obtain such information as he would require, from the clear and lucid diagrams given. It is needless to state, that as ships are now-a-days built largely in "classes," each class comprising from two or three to as many as a dozen ships, all from the same designs, a single cut and description will readily cover an entire class, and hence the 400 cuts represent in reality something like 1,500 ships.

Self-Propelled Vehicles. A practical treatise with illustrations. By J. E. Homans, A.M. 8vo. Pp. 652 + vii. Bound in black vellum, gilt top, gold titles. 1904. New York: Theodore Audel & Company. Price $2.00.

In presenting the new edition of this work, the publishers announce that the book has been thoroughly revised, and in large part rewritten. There is a vast amount of useful information packed into its 652 pages, and it is so well arranged and so clearly stated that the reader cannot fail to find and comprehend the information given.

The general principles of automobile construction and operation, including steering devices, underframes, wheels, tires, bearings, lubricators, are included in the opening chapters. Then follows an exhaustive account of the theory, construction and operation of gas engines, occupying over 100 pages. Several typical engines are taken up and discussed separately, and their properties, as regards balance, speed and power, are discussed in the light of fundamental principles. The explanations of the governing devices are clear and valuable, while the discussion of ignition, including the hot tube, and the primary and secondary sparks, cannot fail to prove of the utmost value.

Probably the most interesting feature of the entire work is the extensive chapter devoted to the description of leading types of gasoline vehicles, including the most important of American build. In this chapter the reader is informed as to the details of the transmission and control apparatus in each case. The chapters on electric vehicles are also full, and certain to prove of practical use to the owner and chauffeur. Taking the subject of electrical apparatus from the fundamental principles of circuits and batteries, the discussion passes to the theory and operation of generators and motors; the laws of motor operation; the laws involved in computations of speed and power, and the varieties of motor suited to road carriages. Electricity meters are described and illustrated in a brief chapter, and the principles underlying storage batteries, their construction and care, are outlined. All necessary information is given, and the merits of several types of steam carriage are fully set forth.

The book closes with a chapter on "Gasoline Vehicle Management," excellent for its completeness and "useful hints"; another on gasoline cycles that covers the general principles involved in this type of motor.

As to the method of presentation, one remark is in place: since the advent of the motor carriage has created a widespread interest in matters mechanical, bringing many persons who lack previous acquaintance with the mysteries of engine construction and operation into intimate daily contact with practical problems and situations, it is essential that such a treatise as the present one should give the facts with as few technical terms as possible. In this respect the best book on the subject is somewhat like the best automobile carriage—the simplest.

An exceedingly full index at the close of the book puts its contents into "ready reference" shape, an advantage of no small importance in view of contingencies sometimes happening in the use of the 'mobile.

Record of American and Foreign Shipping. Pp. 1,294. Size 8 by 9 1-2 inches. Price $5.00. American Bureau of Shipping, 66 Beaver street, New York.

The volume for 1905 of the "Record of American and Foreign Shipping" (American Lloyd's) which is the thirty-seventh annual issue of this valuable register is now being delivered to subscribers.

The record contains full reports and particulars of about 17,000 vessels ranging from the infrequent ketch to the full-powered transatlantic liner and flying the flag of every nation, alphabetically arranged with much detail as to build, ownership, and condition. This information forms the bulk of the annual volume but it also contains rules for the construction and classification of all classes of vessels with illustrations and tables all of utmost technical and practical value; revised rules for the construction of machinery and boilers, electric installation and refrigerating apparatus on shipboard.

The volume contains names of vessels which have been changed; list of compound names arranged alphabetically by last word of name for ready reference; list of addresses of prominent shipbuilders, dry-docks and marine railways of the United States; list of owners of vessels, all of much value to the shipping interests. The work is approved and endorsed by the important boards of underwriters of the United States, and is accepted by the merchants and underwriters throughout the world as a standard classification of shipping. Supplements to the volume issued semi-monthly keep subscribers informed of new vessels constructed during the year, with reports of repairs to old vessels, and other useful information.

Mechanical Appliances, Mechanical Movements, and Novelties of Construction. By Gardner D. Hiscox, M.E. Pages 396. Illustrations 970. Price $3.00, bound in cloth. New York: The Norman W. Henley Publishing Company. 1904.

This book, while complete in itself, is in fact a continuation of the author's "Mechanical Movements, Powers and Devices," which has now run into its tenth edition. The aim has been to present to readers information regarding nearly all conceivable devices for producing motion or accomplishing mechanical results. The machines incorporated cover an immense field, and have been carefully selected to supply the needs of the student seeking either general or special information. They will be found fairly representative of the power devices of the modern industrial world, as well as many of those now generally superseded by later and more efficient substitutes. From the multitude of devices described (and in every case illustrated), might be mentioned, in passing, such items as conveyors and elevators, prony brakes, thermometers, various types of boilers, solar engines, oil-fuel burners, condensers, evaporators, Corliss and other valve gears, governors, gas engines, water motors of various descriptions, air ships, motors and dynamos, automobiles and motor bicycles, railway block signals, car couplers, link and gear motions, ball bearings, breech block mechanism for heavy guns, and a large accumulation of others of equal importance. The descriptions are terse and brief to a degree, but are clear and well cover the points to be made. Taken in conjunction with the accompanying illustrations, they will readily afford a splendid idea of what the author intended to convey.

One chapter or "section" is devoted to "Navigation, Vessels, Marine Appliances, etc." Beginning with curious forms of boats used by the North American Indians and the South Sea islanders, the reader is carried through descriptions of the forms of racing yachts, various types of screw propellers, catamarans, steering gears, automobile torpedoes, submarine boats, knots, splices and hitches, buoys, and many other things nautical.

The last section is devoted to the inventions of the multitudinous followers of the Keely motor school:

"Although the author has not the slightest desire to encourage the hopeless pursuit of perpetual motion, he has, nevertheless, thought it advisable to dwell at some length on the exceedingly ingenious means devised by misguided inventors in their endeavors to solve an unsolvable problem. The pages in which perpetual motion machines are described may induce those who still believe in this *ignis fatuus* to bend their energies in causes more worthy of their zeal. Moreover, it may be that some of the mechanical movements which have been evolved by the perpetual motion inventor, although they may not attain the end sought by him, may still be applied with profit to his instruction in true mechanical principles and to avoid the errors committed in the search on the lines of this folly of past centuries. This in itself is a sufficient justification for the insertion in this volume of the section on perpetual motion."

Typograpy is excellent; cuts clear and well drawn. The work may be heartily recommended to inventors, patent attorneys, machinists, engineers and all others engaged in the mechanic arts, or interested in the design of any form of machinery.

Gruppeneinteilung fuer die Gewicht und Kostenberechnung von Schiffen. By F. Meyer. Size 4 1-2 by 6 1-2 inches. Pp. 52. M. Driesner, Klosterstr. 45, Berlin, Germany. Price $1.25.

This pamphlet contains a list of names of all parts entering into the construction of a merchant ship. The book is supposed to be a help in calculating the weights, as the author states that frequently a number of small parts are omitted in weight calculations, causing serious errors in displacement and estimated price. The author has endeavored to classify all the material, although he admits incompleteness, as each shipyard has a different method of calculation. A table is also included which shows a system of tabulating the cost of the different parts.

A Modern Battleship. New York: The Derry-Collard Company; and London: The Locomotive Publishing Company. Price 50 cents; edition-de-luxe, framed, $5.00.

This is an engraving 36 inches long, on plate paper 44 by 28 inches, of the inboard profile of a battleship of the *Connecticut* class, showing in great detail the contents of the various compartments and the multitudinous appliances obtaining on a ship of this character. Each item is numbered, and the index to the nearly 500 parts is printed below the engraving. The value of such a pictorial description for conveying accurate information to those who may require it can hardly be overestimated.

The "Mechanical World" Pocket Diary and Year Book for 1905. Size 4 by 6 1-4 inches. Pages 391. Figures 66. Manchester: Emmott & Co., Limited. Price six-pence, net.

Within a small compass, in a book conveniently carried in the pocket, have been collected a large number of tables of engineering data of all descriptions, from the usual mathematical and trigonometrical tables to horsepower, steam and vacuum tables, tables of the properties of I- and Z-bars, shafting and the strength of materials, electrical constants and wiring tables, hydraulic data, tables of bolts, nuts and threads, conversion tables between metric measures and the corresponding British units—in short, all of the usual data and tables to be found in the general engineering reference books. In addition to this are to be found many "chapters" or notes on various subjects of an engineering character, such as engines, boilers, valve setting, pumps, oil and gas engines, belt and rope driving, electric machinery, power transmission and devices, and a multitude of other items of interest to the engineer. One of the notes which will appeal with particular emphasis to our readers, is on the speed and power of small launches, giving, among other things, three tables: values of $D^{\frac{2}{3}}$ for displacements from 500 to 24,000 pounds, where D is expressed in gross tons; values of S^3 for speeds from 5 to 19.5 miles per hour, where S is expressed in miles per hour; and values of C, the Admiralty coefficient, for a special case, at speeds from 7 to 15 miles per hour.

In the rear of the book are a diary and blank pages for memoranda. A splendid and very complete index renders the book exceedingly easy of access, and adds enormously to its value as a work of ready reference.

QUERIES AND ANSWERS.

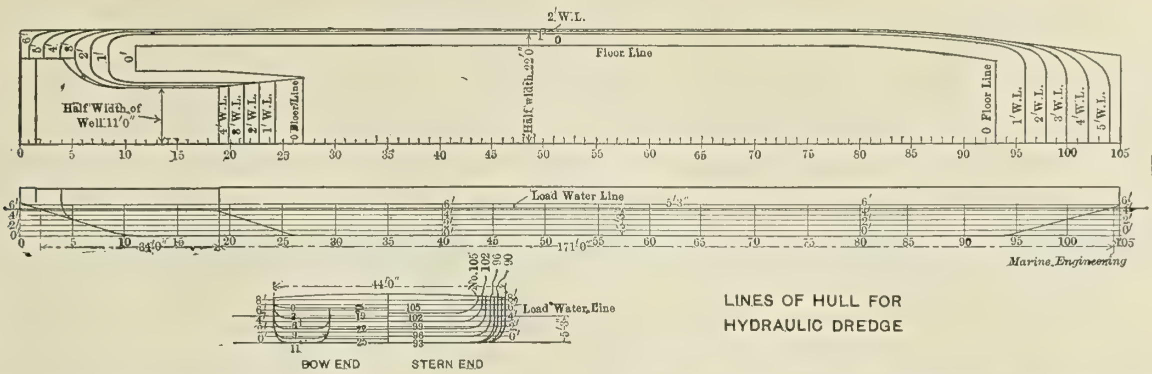
All reasonable questions concerning marine engineering received from and signed by subscribers will be answered by the editor in this column. All communications must bear the name and address of the writer.

Q. 265.—Will you kindly answer the following queries in the columns of your valued paper?

1. What I. H. P. would you advise putting into a vessel of the dimensions and forms indicated on the inclosed blue print, in order to obtain a speed of 10 knots per hour in still water? The area of midship section is 227 square feet; the wetted surface is approximately 9,680 square feet; and the displacement at load water line is 1,050 gross tons.

2. What rules are applicable to such cases as this, by the use of which the horse power required can be determined with some hope of obtaining results on trial, that will correspond with the calculations? X. M. T.

A.—The indicated horsepower required for propelling a ship



LINES OF HULL FOR HYDRAULIC DREDGE

at any stated speed is given by the expression:

$$I.H.P. = \frac{D^{\frac{2}{3}} S^3}{C},$$

where D is the displacement in tons, S the speed in knots, and C a coefficient known as the Admiralty coefficient, and varying with the form of the hull, the size of the ship, and the speed desired. In the present case it is not at all certain what value of coefficient will be applicable, because the form of the hull is very unusual for anything but very low speed. Assuming, however, that the value may be placed at 149, we find that the horsepower will be represented by the expression:

$$\frac{103.3 \times 1{,}000}{140} = 738.$$

It thus follows that if an engine of 750 horsepower be fitted to the hull, it is quite reasonable to expect that the speed of 10 knots might be realized.

Q. 270.—Kindly inform me in your next issue of MARINE ENGINEERING. (1) Which would pull the most at the greatest speed, and why, the *Kaiser Wilhelm der Grosse* of 28,000 horsepower, or 28 tugs of 1,000 horsepower each?

(2) What process can I use to figure out the area of a funnel?

J. L. D.

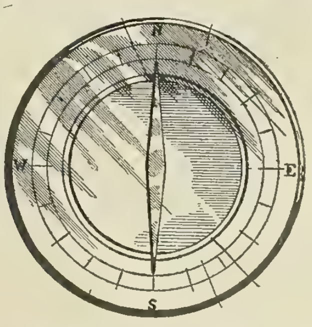
A.—Twenty-eight tugs of 1,000 horsepower each could tow a greater weight than could the *Kaiser Wilhelm der Grosse* of 28,000 horsepower, for the simple reason that the tugs were designed to develop 1,000 horsepower each at the speed at which they would tow, whereas the *Kaiser Wilhelm der Grosse,* when the engines are developing 28,000 horsepower, is running at full speed, and all of the power is required in overcoming friction and the ship's own resistance, there being nothing left for towing.

(2) The cross sectional area of a funnel is easily figured out from the grate surface, the proportion being 1 square foot in the funnel to every 6 or 8 square feet of grate area which the funnel serves.

SELECTED MARINE PATENTS.

774,693. STEERING APPARATUS FOR SHIPS. JOHN PETERSON, ABENIA, N. Y.

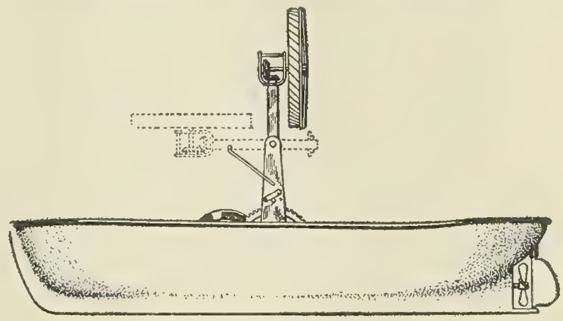
Claim.—5. The combination of a compass having an oscillatory element disposed concentrically beneath its magnetic needle, electrical conductor



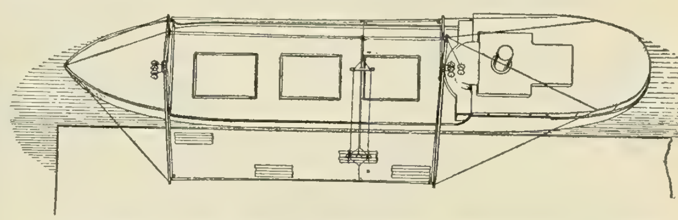
rails upon said movable element, an electrical generator, electrical conductors connecting with electrical generator, and conducting rails in open circuit, a circuit-closing device carried by the magnetic needle of said compass and coacting with said conductor rails, means for oscillating said oscillatory element, and a set-screw for securing said oscillatory element in an adjusted position, substantially as described. Nine claims.

775,971. BOAT PROPELLER. HERMAN HELMEKE, ST. LOUIS, MO.

Claim.—3. In a boat, suitable standards, a drive shaft mounted on the same, a propeller shaft, intermediate gearing between the propeller shaft and drive shaft, a gear wheel on the drive shaft, a tilting frame mounted to swing vertically on the standards, a shaft disposed longitudinally in said frame, and adapted to have one end co-operatively connected to the afore-



said gear wheel, a rotatable sleeve enveloping the shaft on the frame, an upper terminal fork carried by said sleeve, a wind wheel shaft on the fork, a bevel pinion on the shaft, a corresponding pinion on the upper end of the longitudinal shaft meshing with the aforesaid pinion, means for rotating the sleeve to effect the proper angular adjustment for the wind wheel, and means for locking the sleeve when once adjusted, substantially as set forth. Seven claims.



777,122. HOISTING AND CONVEYING APPARATUS. THOMAS S. MILLER, SOUTH ORANGE, N. J.

Claim.—15. In a boat, in combination, two masts, booms extending outboard therefrom, a hoisting rope, a swinger rope engaging therewith, a hoisting rope sheave traveling between said masts, a swinger rope sheave traveling between said booms, a traction actuator connected with both of said sheaves, a swinger actuator and a hoist actuator; each of said actuators being located adjacent to one of said masts. Twenty-one claims.

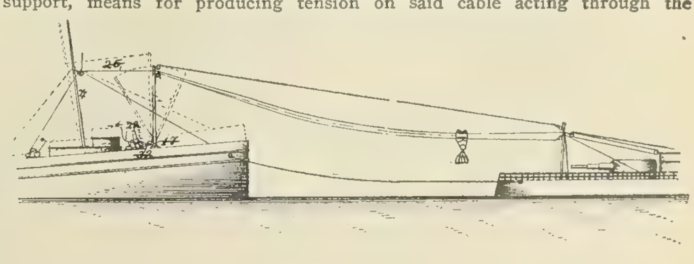
777,619.—DEVICE FOR USE IN HYDRAULIC ENGINEERING. DANIEL J. FEUERLOSCHER, GRATZ, AUSTRIA-HUNGARY.

Claim.—1. The device consists of a body formed by inclosing concrete in an outer casing or envelop formed of boards, battens, or laths lined with sack-cloth or the like and tied at suitable intervals throughout its length, similarly to a fascine, and which being sunk in the water before the concrete has set will adapt itself to the configuration of the bottom, thus preventing underwashing or undermining of the base of foundation. Four claims.

777,685. CONVEYING APPARATUS. THOMAS S. MILLER, SOUTH ORANGE, N. J.

Claim.—1. In combination, a boat, an elevated support thereon, a rope extending from said support to another support located off of said boat, a load carriage traveling to and from said boat on said rope and a means for maintaining a normal elevation of said load carriage during its excursions, which means consists of mechanism whereby the yielding power of a fluid is applied in opposition to the strain on said rope, substantially as described.

2. In a conveying device the combination with two relatively movable bodies each carrying a cableway support, one of said supports containing a hinged member, a cable extending from said hinged member to the other support, means for producing tension on said cable acting through the



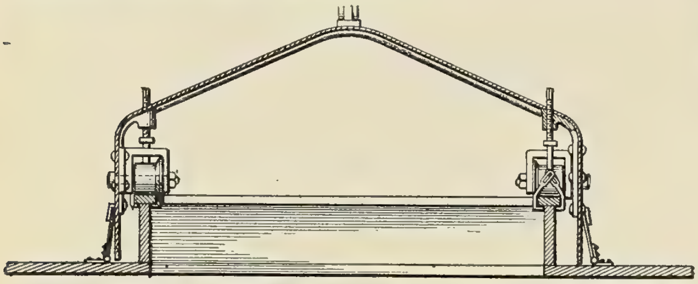
hinged member, and means for transferring loads over said cable comprising ropes leading substantiallly through the pivot-axes of the said hinged member.

5. In combination two boats, a cable extending between said boats, a hinged support for said cable on one boat, an engine connected with said hinged support to produce tension on the said cable, a carriage traveling on said cable, a traversing rope for said carriage, and guides for said traversing rope located to substantially coincide with the pivot-axes of the hinged support.

16. Apparatus for transferring cargoes from one vessel to another comprising an anchorage to a fixed support on one vessel and a tower oscillating from its point of support on the other vessel, a traveling cable passing from one anchorage to the other and return, a pulley on one of said anchorages around which said cable passes and means to maintain a constant tension on each portion of said cable. Sixteen claims.

777,878. HATCH FOR SHIPS. EARL C. AKERS, PORT HURON, MICHIGAN.

Claim.—1. The combination with a ship's deck and a hatchway therein, of coamings rising from the deck, a hatch cover comprising a plurality of cover sections which are joined end to end by water-excluding joints and provided with rollers which rest on said coamings and are adapted to roll thereon from one end of the hatch to the other, and means for separately fastening the cover sections to the coamings.

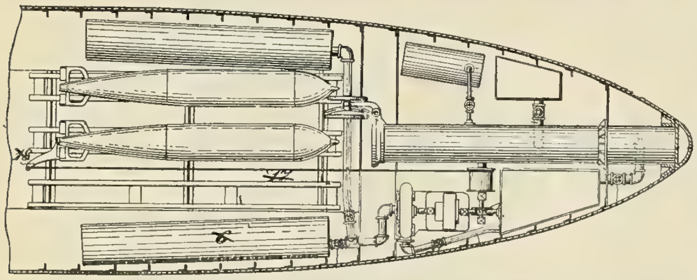


4. The combination with a ship's deck and a hatchway therein, of coamings rising from the deck, a hatch cover comprising a plurality of cover sections having at their sides and ends depending portions located laterally outside of the coamings, means for supporting said cover sections on the coamings, means for providing substantially water-tight joints between the meeting margins of the sections, plates hinged to the deck and adapted to swing upwardly against the said depending parts of the cover sections and latches for fastening the hinged plates in their upper position.

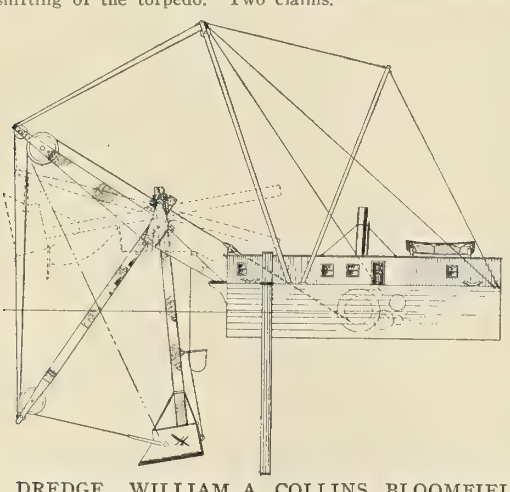
15. The combination with a ship's deck and a hatchway therein, of coamings rising from the deck, a hatch cover extending across and supported on said coamings comprising a plurality of cover sections which are transversely corrugated, the meeting margins of adjoining sections lapping one over the other with the corrugations meeting in interfitting relation, means on the adjacent margins of the cover sections for positively locking the same together and means for exerting tension on the interlocked cover sections longitudinally of the hatchway. Seventeen claims.

778,339. COMPENSATING DEVICE FOR SUBMARINE BOATS. LAWRENCE Y. SPEAR, GREENPORT, N. Y., ASSIGNOR TO ELECTRIC BOAT CO., N. Y., A CORPORATION OF NEW JERSEY.

Claim.—1. This invention relates to the class of submergible and submarine boats which carry torpedoes and have means for expelling them; and it has for its object improved means for compensating the weight of



torpedoes moved in a fore and aft direction within the boat with the purpose in view of maintaining constant or very nearly constant the fore and aft center of gravity of the system at all times during the shifting and after the shifting of the torpedo. Two claims.



778,634. DREDGE. WILLIAM A. COLLINS, BLOOMFIELD, N. J.

Claim.—4. In a dredge or the like, the combination with a boom, a dipper and a dipper handle, of an operating chain secured to the dipper and passing over the outboard end of the boom, means for operating said chain, and a radial arm mounted on the boom and interposed on the operating chain between the dipper and the outboard end of the boom, said arm being adapted to regulate the working angle of the operating chain.

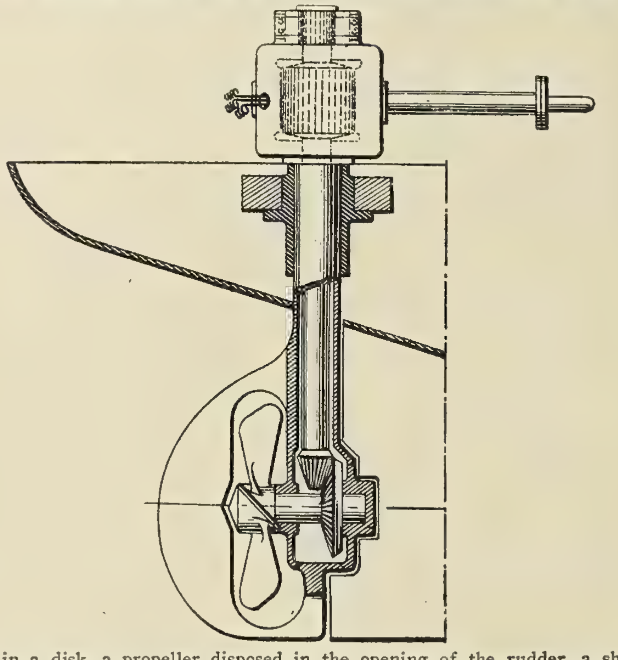
39. In a dredge or the like, a boom, a support therefor, means for swinging said boom in a horizontal plane, a dipper, a dipper handle, carried by the boom and swingable in a vertical plane, an operating chain secured to the dipper and rove through a sheave at the outboard end of the boom, means for operating said chain, a radial arm swingable in a vertical plane and interposed on the operating chain between the dipper and the outboard end of the boom adapted to regulate the working angle of the operating chain, a rope secured to the outer end of the arm and adapted to limit the descent of said arm, a slack-take-up for said rope, and a stop adapted to limit the inboard movement of the radial arm.

50. In a dredge of the character set forth, a radial arm substantially oblong in cross section and having its broader sides facing inboard and outboard.

51. In a dredge, a boom, a dipper handle, and means for operating the same and an adjustable stop on the upper end of the dipper handle. Fifty-five claims.

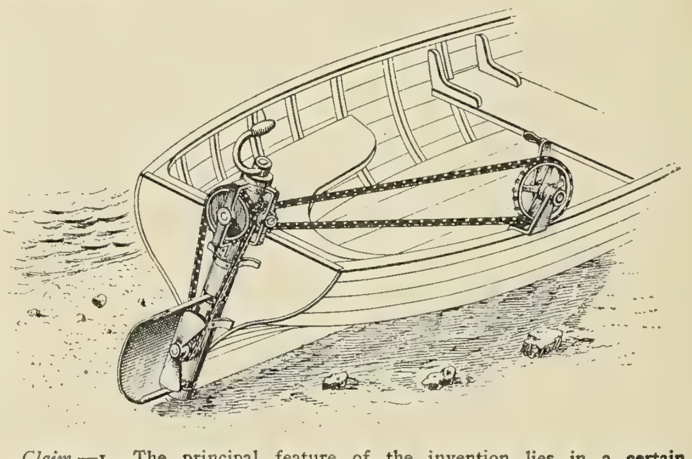
778,435. BOAT PROPELLER. GEORGE F. ATWOOD, WAKEFIELD, MASS., ASSIGNOR OF ONE-HALF TO HERBERT C. HALL, TRUSTEE.

Claim.—1. The combination of a boat, a vertically disposed sleeve or hollow post journaled in a bearing on the boat, a rudder carried by the sleeve or post and having an opening, a casing arranged on the upper end of the post, and having a hollow handle terminating at its outer



end in a disk, a propeller disposed in the opening of the rudder, a shaft carrying the propeller and journaled in the lower portion of the sleeve or post, and provided within the latter with a beveled gear, an upright shaft journaled in the sleeve or hollow post, and provided with a beveled gear intermeshed with that on the propeller shaft, an electric motor comprising a rotary armature fixed directly on the upright shaft, a source of electric energy, a hand grasp pivotally connected to the outer end of the hollow handle whereby it is adapted to turn on its axis, and having a disk opposed to that of the handle, and coacting means on the disks for controlling the supply of electric energy to the motor. Four claims.

778,763. BOAT PROPELLER. JOHN SALOM, NEW YORK, N. Y., ASSIGNOR OF ONE-THIRD TO JOHN F. CUNNINGHAM, NEW YORK, N. Y.



Claim.—1. The principal feature of the invention lies in a certain novel arrangement which enables the device to be easily and quickly applied to or removed from the transom of a boat. This adapts the mechanism particularly to boats which are to be launched frequently, and the principal advantage lies in the fact that when the boat is hauled up on the shore or in the davits of a vessel the propelling device may be removed from the transom and stowed safely away. Seven claims.

Marine Engineering

Vol. X. MARCH, 1905. No. 3.

THE DESIGN AND MAKING OF SAILS.*

BY ADRIAN WILSON.

The first consideration in the matter before us is the making of a proper distribution of the areas of the drawing power of sails. In a great measure the making of a plan will depend, of course, on the form of the hull to which we wish to apply it. Boats of radically different lines will want different plans, and, to determine as to what is the correct thing for a given set of lines, we shall be obliged to resort to a comparison to be obtained from other boats which may have the same essential characteristics in design as the one we are to supply with a plan. Given one or two known quantities as a basis for starting the plan will simplify our work in its early stages. The points mentioned are to know the location of the various centers; that is, the center of buoyancy, and also one other most important point, the center of lateral plane.

Using the center of lateral plane as a starting point, and, having decided on a certain amount of area, it should be so drawn in on the plan as to bring the center of effort a little in advance of the lateral plane. The distance to be placed between these two points is to be determined, to a great extent, on the form of the boat, as to her inclination to shift these underwater centers as she increases her angle of heel. In the later designs, those built to our latest racing rules, we find a tendency in all these modern boats to upset calculations which had become almost exact in our older designs.

A SHIP WITH DOUBLE TOPSAILS.
(Photo by W. H. Rau.)

The new boats with extreme overhangs, so designed as to increase their length of water-line as they increase the angle of heel, unquestionably shift the under-body centers, and the result is that while a boat may balance perfectly in a light wind or at a short angle of heel, she may be inclined to do something entirely different when held at an increased angle, and the question arises in my mind if anything can be done by which this can be obviated

*Paper read before Massachusetts Institute of Technology, Jan. 13, 1905.

in a sail plan. The shape of a sail for a boat whose design contains elements so likely to cause the difficulty mentioned is a hard problem to solve.

Our method of finding the center of effort is a very simple one, and I find that it will work out correctly every time. But very seldom are we asked to design a sail plan for a new boat, as today this is all done for us by the designer; often, however, we are asked to correct the sail plan of some boat which is radically wrong and cannot be made to steer as she should, and we are often able to make a decided improvement in boats that were very much out. As an instance: We had one customer who insisted that we give him the benefit of our experience on his boat, one of our modern 25-foot L. W. L. boats. The boat carried a bad lee helm, and I found by questioning him that in a good whole-sail breeze she came nearly to a balance with a full mainsail and the smallest or No. 3 jib. We went over her plan very carefully, and after measuring her under-water profile, or sheer plan, we made up our minds that a mistake must have been made in the designer's office in locating her center of lateral plane. Of course, knowing that she nearly balanced under the sails as mentioned above, we saw that the center of effort in these two sails should be the center of effort for her mainsail and large jib, and, in order to bring this into its proper relation to the center of lateral plane, it became necessary to alter the whole rig. We shifted the mast aft and cut off the bowsprit, and changed the mainsail (as shown in Fig. 1), but had to still keep to the class area.

SAIL MAKING BY MACHINERY.
(Photo by G. E. Dow.)

Now, with our center of effort seven inches forward of the center of lateral plane, the boat has worked in a most satisfactory manner and is all the owner can wish for; in fact, she has won a number of races from boats that easily beat her before the alterations.

And again, before going into the discussion of shape and proportion of sails, one other consideration must be given, as to the different conditions under which a boat may be used. By conditions under which she is sailed I mean weather and locality, and in using the word conditions I wish it understood as referring to the strength of the winds. In our experience as sailmakers almost the first question we ask a customer is: "Where do you use this boat?" We have found that it makes a vast difference as to the location, for at the different points along our coast we find the weather conditions so entirely different as to cause us to make very different recommendations for a sail made for use in Buzzards Bay or Long Island Sound or at Marblehead. In our opinion the sail plan for a 21-footer for use at Marblehead should be quite different from one for use in Buzzards Bay. At Marblehead the weather conditions are such that we would recommend a very high, narrow plan, while at Buzzards Bay we would recommend a lower, broader plan for the same design. The conditions at Marblehead are, on an average, light winds. Also, the wind currents are high up from the water, and what might well be called streaky currents, the wind being found in veins, a peculiar feature of this locality, especially in light winds.

I have no real authority for this statement, but should judge that my statement would stand some test. At Buzzards Bay the prevailing winds are southwest, and strong and heavy, the sea breeze blowing in damp and strong. As we ship our sails to many different localities we find it quite to our advantage to inquire into and study these conditions. Possibly San Francisco Bay may be an interesting example of these conditions. At first it was a difficult problem with us, and, in fact, it took about two seasons for us to accomplish the best results there. The conditions there are peculiar in that the trade wind blows directly into the harbor and generally right up the bay, taking the channel or center of the bay. Starting out from the city side of the bay a yacht will have a soft, light wind blowing from four to seven miles an hour. As she approaches the channel or center of the bay she enters the strong current of the trade wind until, reaching its center, she has a wind of from 25 to 30 miles an hour, and goes out of this as she reaches the other side of the bay. So, practically, she sails from a light wind through a strong one into another light wind, and here we find a double condition to contend with. Sails made for use in these waters are really a compromise between what we would make for the two conditions alluded to earlier. Knowing the conditions of weather under which the boat would sail, it would be a choice of either one of the plans mentioned—that is, the high, narrow plan, the low, broad plan, or a compromise between the two.

Let us consider first the important characteristics of the light-weather sail plan. In all of these plans the angle of the gaff or peak of the sail is a most important factor and is deserving of your greatest consideration. We have found from experience that the high, narrow sail will not bear so high an angle of peak as the low, broad sail plan. In order to get the best results for light conditions, it of course becomes necessary as the hoist is increased to shorten the gaff, and take 65 degrees maximum and 50 degrees minimum as a basis for all peak angles. As I say, taking 65 degrees as a maximum, as the hoist is increased and the gaff is shortened, the angle of peak should be lowered. I am speaking of a restricted area.

SAIL MAKING BY HAND.
(Photo by G. E. Dow.)

In the present raceabout class an angle of 60 degrees on the following dimensions of mainsail will be found to give the best results: Hoist 22 feet 3 inches, head 13 feet 9 inches, foot 24 feet, and leach 37 feet; 480 square feet in the mainsail and 120 square feet in the jib. The illustration before you is what we consider one of our best 21-footer sail plans for light conditions. In the proportioning of one sail to the other, or in dividing the area into the two sails, mainsail and jib, this plan is a very excellent one and shows the result of careful study as to the best result to be obtained in dividing the 600 square foot area. (Fig. 2.)

To make a comparison of one or two plans I will take first one of our champion 25-footers, and illustrate the point as to overpeaking the mainsail by explaining how at first this was a very unsatisfactory sail, and, by a slight alteration, was so greatly improved as to make the boat an easy championship winner. The sail as seen by myself, under almost ideal conditions, was far from satisfactory, and had a very serious fault in that it showed entirely too much bag in the upper forward angle of the sail. If the peak was set up to the angle at which it was designed, the sail

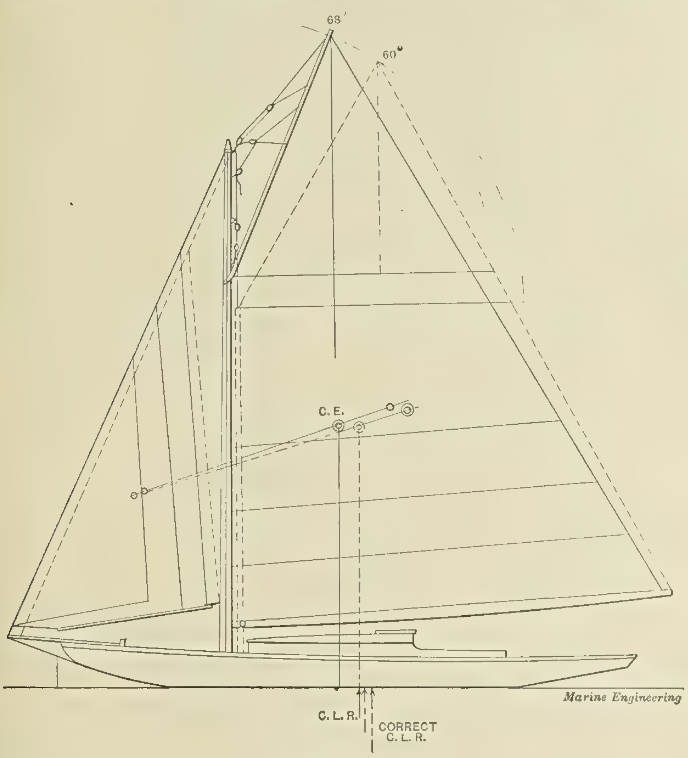


FIG. 1.

had the bad fault mentioned, and the yacht had to be kept off to allow the sail to be kept full of wind. Now, in order to lessen the bag mentioned, the peak was dropped, with the result that the gaff swung off to leeward, and then the boat would not reach as fast as she should. The correction was made by cutting down the angle of peak five degrees, with the result of getting an almost ideal sail. (Fig. 3.)

With the amount of area divided into the two sails of a jib and mainsail rig, care should be taken to so place the sails on the boat that one will be entirely independent of the other; that is, it will be found of much advantage if the jib is placed far enough forward so there can be no draught of wind or air current passing from the head-sail to the lee side of the mainsail. If the two sails are so close to each other that the current of wind from the jib strikes the lee side of the mainsail, it is more than likely to lift the forward part or luff of the mainsail out to windward, and, of course, that part so affected is a dead loss to the boat. The sails should be so placed that every inch of the mainsail may be doing its full work. Especially should the head of the jib be kept well away from the mast, as the upper part of the head of the jib is much nearer the mast than it is at the deck. Also, the upper part of the mainsail is at a broader angle than the boom. So you may readily see the importance of keeping the jib clear of the mainsail.

Possibly I should have given you earlier the names of the different sides of the sail. On a mainsail that part which is next to the mast is called the luff; that part following the line of the boom is the foot; and that part following the gaff is the head. The after side of all sails is the leach. The same applies to the jib. There the luff is that part attached to the stay, and the leach and foot as before.

In designing head-sails this question of one sail interfering with the work of another is of great importance. In a plan where the head area is divided into two sails this question should receive great consideration. In our older plans of boats, designed and built fifteen or twenty years ago, when the double-head rig or cutter rig first came into use in this country, we at first had a great deal of trouble in getting satisfactory head-sails, and the greater part of the trouble was from the cause I have just mentioned.

On a single-masted boat the head-sails are called forestaysail and jib, but properly speaking they are really foresail and jib, as the name forestaysail should really apply to the first sail forward of the masts on a schooner. In either rig, sloop or schooner, the two sails must be so arranged as to have the least interference possible with each other. Care must be taken to keep the jib from coming too close to the forestaysail, and one way to succeed in this is to be careful not to get the points at which the two sails attach to the mast too close to each other.

The jibstay should be a very considerable support to the masthead. And the forestay, while being kept as much as possible clear of the jibstay, should not be placed so low down on the mast-head that the strain of the halyard in setting the sail may be in any way likely to assist in pulling forward that part of the mast near the jaws of the gaff.

The boom should be placed high enough from the deck so that the helmsman may have a good opportunity to see out under it at almost any angle of heel. On a 21-foot raceabout 18 inches is a convenient height, and at the taffrail 3 feet should make a good convenient clearance, and also keep the end out of the water when running with a free wind. Now, in getting the right length of

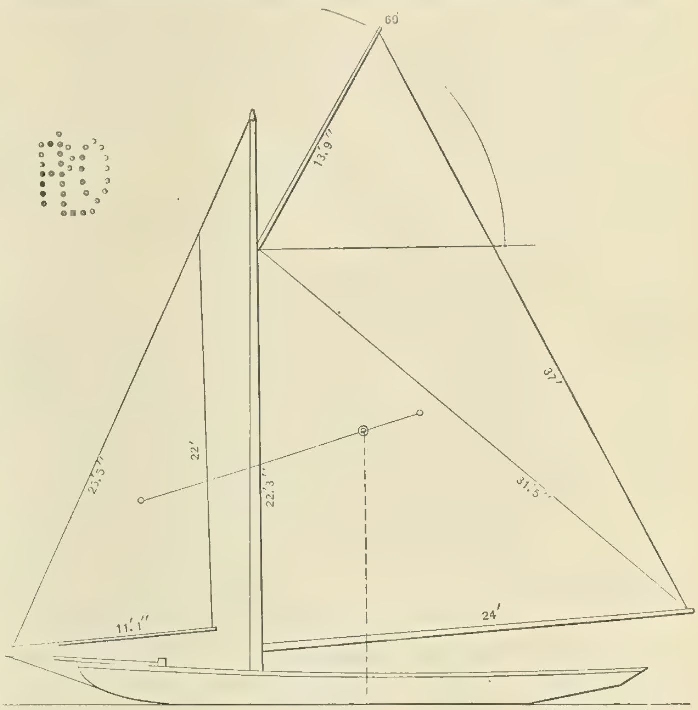


FIG. 2.

mast for a boat of this class, or any class (as this rule will invariably apply in all cases), do not lose sight of one very important point: the lower peak halyard block should never be lower than a level line drawn through the center of the gaff. This will always insure your being able to hold the peak up to its proper position. The lower peak angle will, of course, have a greater tendency to thrust or push against the mast at the jaw of the gaff than the higher angle. Should this occur it can be remedied by a strut and stay on the forward side of the mast, which has been adopted on almost all classes of racing yachts to-day, from the 15-footer to the 90-footer, and with this arrangement of rigging the spars can be made much lighter in weight.

The jib on a 21-footer is of the following dimensions: Luff, 31 feet 5 inches; leach, 22 feet; and foot, 11 feet 3 inches; the intersection of the foot and leach being the point nearest to the mast, this distance on the plan I am discussing at this point being 2 feet 4 inches and the head 3 feet from the mast; so you may readily see the care taken to prevent the jib throwing any wind under the lee side of the mainsail. Of course we would not carry this out on a larger boat, as it would not be practical on a sloop or schooner, especially one of size. Possibly I might have covered this point in fewer words by saying that in planning your head-sails do not make them lap one over the other any more than possible. I firmly believe that the best jib is one that does not lap by the forestay at all. In head-sails the foot should be cut high, the forestaysail well up and clear from the deck. Also, the jib should have a high clew (this is the point where the leach and foot intersect). The nearer a jib on leach and foot approaches the same dimensions, the more perfect will be the sail, and especially is this true of jibtopsails. While all of our knowledge on this matter has been gained in a practical way, it has been almost

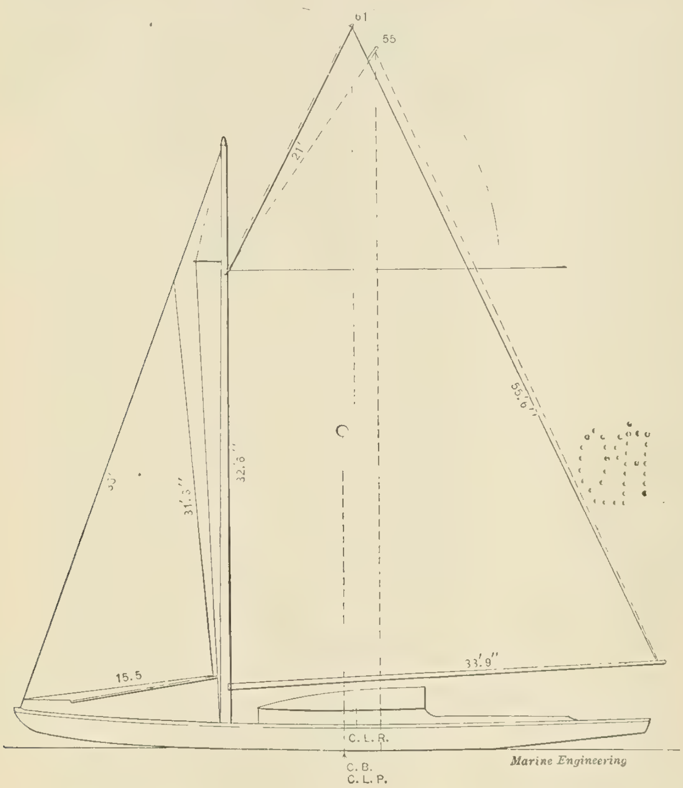


FIG. 3.

the work of a lifetime to educate yachtsmen and designers to these facts. In making plans for schooner rigs it has become almost a custom to place the mainmast at about the midship-section, which on most of the modern plans will be found near the center of the water-line. The foremast will come nearly half way from the mainmast to the stem of the vessel, and on almost all of our schooner plans I find the center of effort will be found just about at the forward side of the mainmast, and the center of lateral resistance from 18 inches to 2 feet aft of this.

The custom of making the mainmast longer than the foremast I also find falling into disuse, and on almost all of our new plans you will see the two masts of about the same height, with some little difference in lengths of the topmasts. The rigging plan should also be a part of the sail plan, as it is most important that the mast and other spars be held as straight and firmly as it is possible to make them. As soon as a mast or boom or gaff begins to bend or buckle out of shape, just so soon is your sail out of shape and losing its efficiency. The shrouds should be placed one from the top of the mast-head leading forward of a center line of the mast to hold the mast-head from springing back, and one from a point as near as possible to the jaw of the gaff, leading aft to hold against the forward thrust of the jaw of the gaff. The jibstay and upper shroud should hold the mast from coming aft. The lower shroud and runner should hold the mast from coming forward.

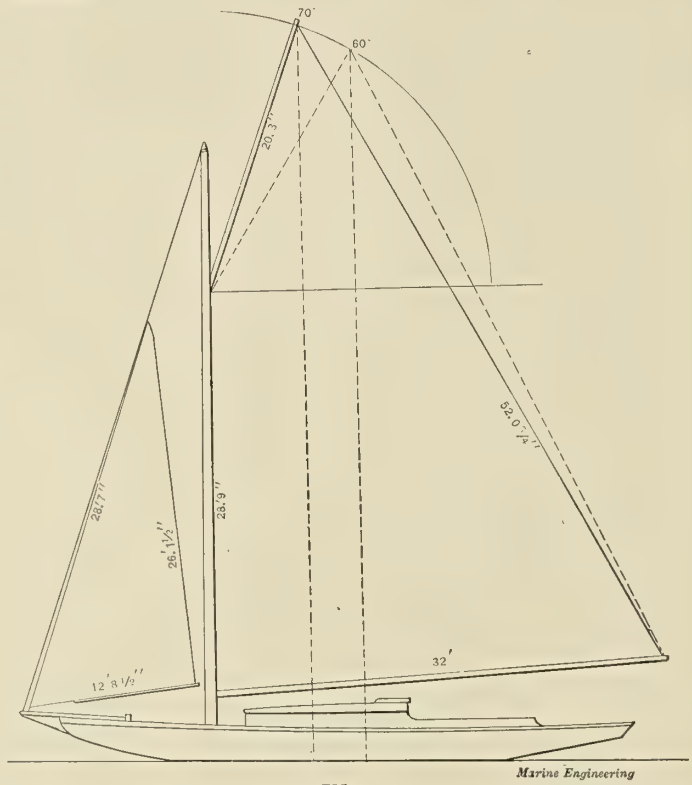


FIG. 4.

Another important point in relation to your sails is to properly trim them. Knowing after a trial at about what angle the main boom should be, great care should be taken to get the head sheets so arranged that they will work to the best advantage with the mainsail. The head sheets should not be too broad or too flat,

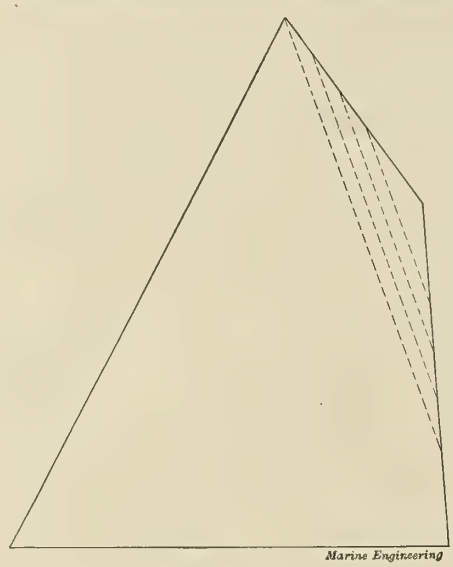


FIG. 5.

and in planning them care should be taken that their shape and proportions are so arranged as to have them sheet at convenient places on deck, or, in the case of the jib, on the rail. Many a boat has never shown her best speed for the reason that her head-sails were improperly shaped or not trimmed at the right angle for their best work with the mainsail.

In considering the weight of canvas for the different classes, it will depend, as I stated in the beginning, a great deal upon the conditions under which a boat will be used. There is a liability of getting the canvas too light for the best work. In the extreme skimming-dish type of boat the lighter the canvas the better, but in almost all other classes the tendency is to get the canvas too light. The yachtsman, from possibly a mistaken idea, thinks his sails should be extremely light for light winds, and the sailor or skipper wants them light so he can handle them more easily. If the matter is left to the sailmaker he will seldom err by getting them too light, as he knows that in using a good weight of material his work will hold in shape longer.

U. S. S. HARTFORD UNDER SAIL, SHOWING LARGE SINGLE TOPSAIL.

(Photo Copyright, 1901, by Enrique Muller.)

In the past few years some radical changes have been made in the arrangement of cloths in cutting sails. It was the custom for many years for all sails to be made with the seams or cloths parallel with the after-leach, but in recent years we have been making sails with the seams or cloths at right angles to the after-leach. In some respects this is a great improvement, as undoubtedly it does away, to a great extent, with the stretching of the sail. The cross-cut sail, as we call the new style, stretches but very little in comparison with the old method, but it is not so strong and will not stand the hard usage of the old arrangement of cloths, and consequently will not wear nearly so long a time. The cross-cut sail is not a new invention at all—it was in use many years ago. In fact, the famous sloop *Maria* had her sails made with this arrangement of cloths.

The reason for these sails not stretching so much can be readily seen if we consider the weave of a piece of canvas. It is composed of a plain weave, or a basket weave, as the weaver would call it, lengthwise of the goods in the warp, and the cross-thread is the filling. The filling thread shows almost no corrugation from the action of the loom; this is all in the warp. In weaving a piece of duck the weaver counts on a take-up of 30 percent in the warp and in the filling only 10 percent. This shows the amount of corrugation in the warp thread and is caused by the warp thread passing up and down over the filling thread. Also, there is a great deal more twist put into the warp than in the filling. Now, as soon as a strain is put onto this fabric, if put on lengthwise of the cloth the corrugated thread gives and you get a certain amount of stretch. But if this same strain is put onto the filling thread there is but very little if any give on account of the small take-up, and so, practically, no stretch. In cutting our sails cross-cut we arrange our goods so that the least stretch comes in line with the greatest strain, and as so much of our work is handled by amateurs this arrangement of cloths is much easier for them than the old arrangement, where there was so much stretch to be taken care of. Thus the cross-cut arrangement simplifies the matter for all concerned.

The cross-cut arrangement is a great improvement in the head-sails. In the forestaysail, jib, or jibtopsail made with the old arrangement of cloths, on the side next to the luff the cloths ended with a long diagonal or gore. This side of the sail was constantly stretching and was the cause of much trouble by the sail being constantly liable to stretch out of shape, and was caused by the fact that the warp thread—the one having so much corrugation—came nearest to the line of strain and consequently stretched more than if the goods had been so arranged as to bring the filling thread in the line of strain. Also, in the cross-cut sail, the diagonal ending of the cloth will of course be a much shorter line and less liable to stretch. In applying this arrangement of cloths to all head-sails and topsails we have found it to be of great advantage.

The many styles or ways of arranging the cloths in sails are too numerous to mention. Among the old sail plans filed away in the loft of my father, R. H. Wilson, of Port Jefferson, N. Y., we find plans dating back to 1836, and, to our surprise, among these we found plans dating from 1836 to 1846 that in topsail and head-sails showed where the cloths had been cut, some at right angles to the leaches and others with cloths at right angles to the luffs, but there were few of the latter. One of our men who worked in the loft at that time remembered that it was then the custom, but was abandoned on account of not having sufficient strength in head-sails. Numberless arrangements of cloths have been tried, some with success; others after trial were found to have had no value. While it may seem to be a fact from observation that our sails of the present day have cloths at right angles with the leaches, this is not the fact, as the cloths or seams are not cut at right angles to the after-leach. The same arrangement of cloths has been tried on square sails on ships, but not with marked success on account of the sails not wearing so long. It was possible that in head-sails no gain was made in going over to the arrangement of cloths parallel to the leaches, as in some of our large coasting schooners the cross-cut arrangement in head-sails is found to be of advantage. In these large four-, five-, and six-masters, it is a rather common occurrence to part a jib-sheet, and many times before the sail can be taken in it is so badly torn as to make it almost an impossibility to repair it; but with the cross-cut arrangement it is not liable to tear so badly but that it can be repaired at a small expense.

All sails made cross-cut become too hard and flat after use, and what stretch does take place tends to put the sail out of business for racing; that is, the longer it is used the poorer it becomes. On the contrary, the sail with parallel cloths, if properly made at first, becomes better the longer it is used; and it will hold good in shape and draught until the cloth becomes entirely useless and has lost all of its life.

In addition to what I have said above, I wish to give a few words of advice in regard to the handling of the sails after they leave the sail loft; for it is a fact that most of the poorly-setting sails that we see on yachts are the direct fault of those who have the handling of them. More poorly-setting yacht sails are made on yachts than in sail lofts. After the sailmaker has finished his

A BARKENTINE UNDER FULL SAIL.
(Photo by N. L. Stebbins.)

work, which he has undoubtedly done in a conscientious manner and to the best of his knowledge, if the sail is not handled in an intelligent manner the work of the maker is of no value; and unless it is handled as it should be, certainly no blame should be attached to the sailmaker.

A yacht sail, in a great many respects, is a wonderful creation, and if you will stop and consider under how many different conditions it is used it seems wonderful that so many of them retain their shape and effectiveness as long as they do. Under the varying conditions of wet and dry, hot and cold, hauled out on their spars to the limit when dry and then allowed to become thoroughly saturated with fog or rain and subjected under these conditions to use in possibly a gale of wind, and when you consider that this area of a thinly-woven material can stand usage of this kind, you must realize that in order to do it great care and study must be used in its construction to enable it to do all these things and still remain a good, useful sail. For years our time and most earnest efforts have been devoted to these very important points, and in working out these points and creating a sail that shall be both useful and also an object of beauty, and a part of the beautiful creation which every yacht should be, we have learned many things and gained a knowledge that should put us into a position to give advice to our customers by which they may be enabled to handle their sails with that intelligence that will tend to obviate many of the difficulties with which the amateur, and, in many cases also, the professional, has to contend. A yacht sail should be two things in one. It should, first of all, contain those elements that will give to the yacht the greatest amount of speed; and it should be a thing of beauty. To the customer can be given a sail that will stand simply as a picture sail, one that while it may be most pleasing to the eye has not the "go" in it that it should have. This is an easy problem to solve; but when we make a sail that will be pleasing to the eye and at the same time develop the greatest amount of speed, then we have to draw on a store of experience and data gained by long practice and a careful working out of details. In sending out new sails it is our custom to attach a tag to each sail, giving its dimensions, and directions as to bending and setting. If these directions are followed and the sail is faulty, either the sailmaker is at fault or some outside reason is to be found. Possibly the spars may not be of sufficient size to stand the strain, and if so should be corrected at once. No sail can set properly on crooked or buckling spars. The man who made the sail knows at what dimensions it should bend. The directions should caution the yachtsman against pulling the sail to the full dimensions in case of damp or cold weather. The duck will contract in cold and especially damp weather; but, if the conditions are favorable, pull the sail to dimensions given on the tag. After the sail is bent onto the spars it should be carefully set as follows: See that on the luff or hoist the sail is hoisted to the tag measurement, and when setting up the peak set it up so that the sail wrinkles well under the jaws of the gaff, as per sketch. (Fig. 5.)

SCHOONER YACHT CORONA, SHOWING CROSS-CUT SAILS.
(Photo by W. B. Jackson, Marblehead.)

This may seem to the man setting the sail to be an exaggeration or an extreme. Not so, for as soon as the yacht is gotten under way the peak halyard begins to give and the peak will slack down. The idea of setting the sail until it is perfectly smooth so that it shows no wrinkles is wrong, for the peak will slack down, and this must be taken into consideration. At first setting, if the day is damp or rainy, the sail should be eased in on the foot and head enough to relieve the tension caused by its shrinking from the dampness.

In setting a topsail great care should be taken to know that the clew of the sail is on a line drawn at a right angle from the topmast to the end of the gaff. This can best be judged by getting off some distance from the yacht in a small boat, as it is impossible to judge from the deck. Careful attention given to this detail will save a great deal of annoyance to the yacht owner, as topsails are the sails most criticised, and all on account of not giving this one fact proper attention and consideration. The headsail depends entirely on the amount of strain put onto the halyard in setting, and this needs careful and good judgment. If your sail is set too hard on the luff it will invariably have a tight leach.

If not set hard enough it will have a slack leach. A warm, pleasant day, with light winds, is most to be desired in setting new sails the first time. Do not use them at first in wholesail or reefing winds, as it is very much against the future development of the sails. The yacht had better lie at her mooring for a week waiting for the best conditions than to spoil the sails the first time they are used. The best sails may not look well at first setting—they may seem baggy and full of wrinkles—but after being underway a short time under favorable conditions they will work themselves into a better shape. Ninety-five percent of the sails we make are used by amateurs, and we have to make the sails to counteract the handling they get, and I think it is astonishing to see the amount of good results we accomplish in working to overcome these conditions under which our work is used. So it is a great gratification to us to know that no better sails are made than the American racing sails. In fact, I do not hesitate to say that the American racing sails are the best produced in the world. Our material is the best, although it has been a hard fight on our part as sailmakers to get it up to its standard. Many different grades of fiber have been tried and experimented with to produce the best duck for use here in our climate. We have used Sea Island, Peeler long staple, Texas, Mississippi, Egyptian, Ramie, and, lastly, pure white silk. Of the grades of cotton used we have found that the long staple Texas will make the best grade of carded goods, but for our fine racing canvas a long Peeler of Texas or Mississippi grade makes a better and firmer grade of cloth than the Sea Island or Egyptian. The silk we have used only in very light balloon sails for cup defense. We have worked these questions out until for our own use we have our cloth manufactured in one mill which weaves for us a cloth which, in its construction, is the result of our own experience.

KNOCKABOUT, WITH CROSS-CUT SAILS.
(Photo by W. B. Jackson.)

So, the reader may see that in order to produce a first-class yacht sail for racing purposes, one that we say will be a thing of beauty and at the same time give the best results as to speed, is no haphazard affair, but the result of long and careful study and experience, to which we have added the most careful working out of every detail.

The Amstelstroom in Collision.

The steamship *Amstelstroom* had a collision with the steamship *Cuxhaven*, of Goole, England, just outside the docks of Goole on the 6th of last October. The *Amstelstroom* was waiting opportunity to enter the docks, while the *Cuxhaven* was just on the point of leaving port. When passing the *Amstelstroom* the *Cuxhaven's* steering engines refused to operate, causing her to take a heavy sheer to starboard and to collide with the *Amstelstroom*. The photograph shown exhibits the damage done.

THE DAMAGE TO THE STEAMSHIP AMSTELSTROOM.
(Photo by James Fisher, Hull.)

The *Amstelstroom* is owned by the Hollandsche Stoomboat Maats, of Amsterdam, having been built at Tynewood in 1885. Her dimensions are 222 feet 7 inches in length, 28 feet 4 inches beam, and 14 feet 7 inches depth. She has four-cylinder, triple-expansion engines, the dimensions being 30-inch, 42-inch, 60-inch, and 60-inch cylinders, with a common stroke of 54 inches. There are two double-ended boilers having a combined heating surface of 7,444 square feet.

The Department of Commerce and Labor reports that during the six months ending December 31, 1904, there were constructed in the United States 542 vessels of a total of 92,598 gross tons, of which total 509 vessels of 72,464 tons were wood and 33 vessels of 20,134 tons were steel. Of the total, 227 vessels of 60,885 tons were propelled by sail and 315 vessels of 31,713 tons were steam.

Comparing the total with that for the six months of the preceding year, we find that it has fallen off almost one-half; the number of ships in the preceding period having been 571, and the gross tonnage 177,067. Totals are as follows:

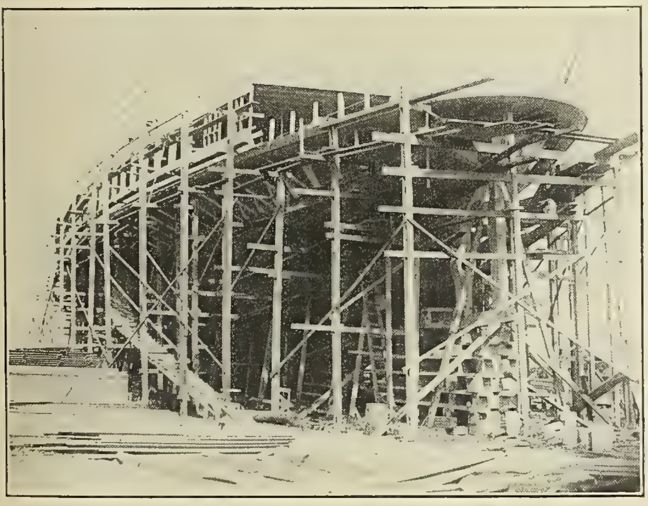
Calendar	year	ending	Dec. 31,	1901,	1,322 ships,	376,129	gross tons.
"	"	"	" "	1902,	1,262 "	429,327	" "
"	"	"	" "	1903,	1,159 "	381,970	" "
Fiscal	"	"	June 30,	1904,	1,094 "	349,573	" "
Calendar	"	"	Dec. 31,	1904,	1,065 "	265,104	" "

NEW FERRYBOATS FOR SAN FRANCISCO HARBOR.

The demand for a fifteen-minute ferry service between Oakland and San Francisco, a distance of some three miles, has led the San Francisco, Oakland, and San Jose Railway Company to contract for two ferryboats of a somewhat novel pattern, capable of a maximum speed of 17 miles per hour, and of a high power of acceleration. Experiment has shown that the smallest interval of time which can be allowed for in the slip is about 3 1-2 minutes, and, as there are only two of the boats, this makes it necessary that the trip should be made in from 10 to 11 1-2 minutes.

THE SAN FRANCISCO ON THE STOCKS.
(Photo, W. S. Atkinson.)

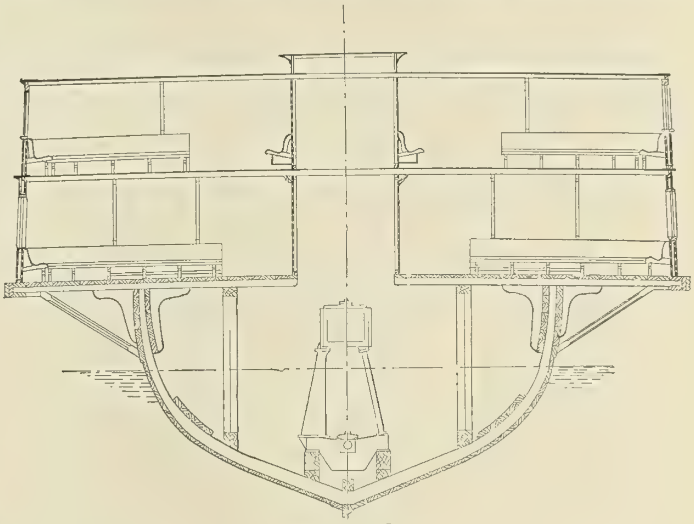
For the accomplishment of this result, Mr. Henry J. Gielow has produced the following design: A boat with a length over all of 201 feet, a length of keel of 176 feet, a beam, molded, of 35 feet 3 inches, a total width over the guards of 58 feet, and a depth of hold amidships of 17 feet 9 inches. The boats are built of wood, the material being Puget Sound yellow fir, except that the keel, stem, and stern posts, rudder post, and frames are made of white oak, the keel being 12 inches square and the frames 6 by 14 inches,



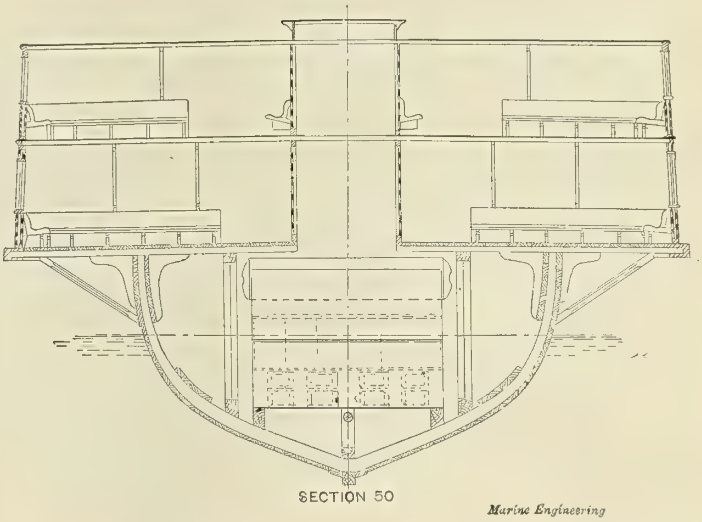
THE SAN FRANCISCO ON THE STOCKS.
(Photo, W. S. Atkinson.)

spaced 24 inches center to center. The main keelson is of pitch pine, 12 inches square, and, as with the keel, is to be fitted in not more than four pieces, from end to end of the ship. The deck beams measure 5 by 7 inches and are fitted to every frame. The outside planking is as follows: sheer strake, 4 by 12 inches; the next six strakes, 4 by 10 inches; garboard strakes, 4 by 12 inches; and the intermediate strakes, 3 inches in thickness and from 8 to 10 inches in width. There are five bulkheads located at frames 12, 25, 49, 68, and 86, thus dividing the ship into six compartments. The bulkhead on frame 49 is recessed for a thrust bearing and fitted with a hinged water-tight door. The hull from the keel up to 18 inches above the designed water-line will be covered with 22- and 20-ounce hard-rolled copper, laid over sheathing felt. Unless the copper sheathing should be pierced this sheathing felt will make the ship at all times absolutely water-tight. The deck planking is of pine, measuring 3 by 4 inches, and fitted in the longest possible lengths, each strake being fastened with one 5-inch galvanized-iron deck spike to one frame, and two spikes to the next.

The main deckhouse is 128 feet 6 inches long with an additional projecting hood of 8 feet 3 inches at each end, making a total length of 145 feet. There will be clear head-room under the carlines of 8 feet 6 inches. On top of the main deckhouse is a saloon deckhouse 86 feet in length, and having a clear head-room



SECTION 48



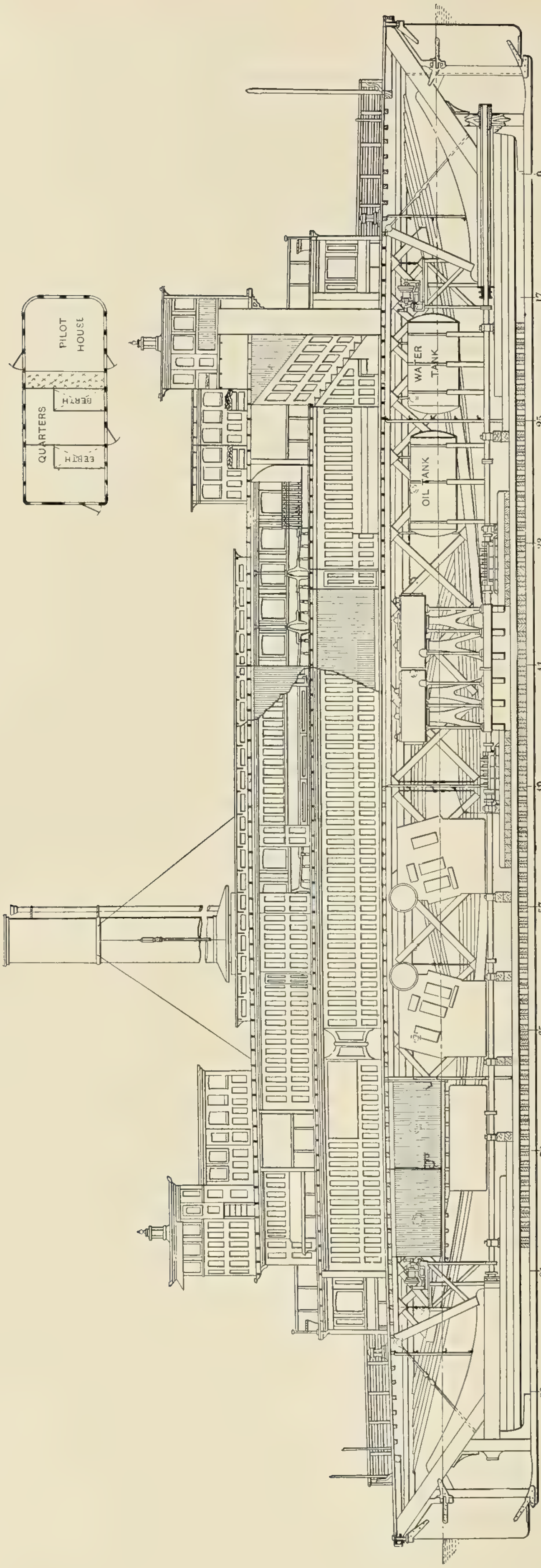
SECTION 50

Marine Engineering

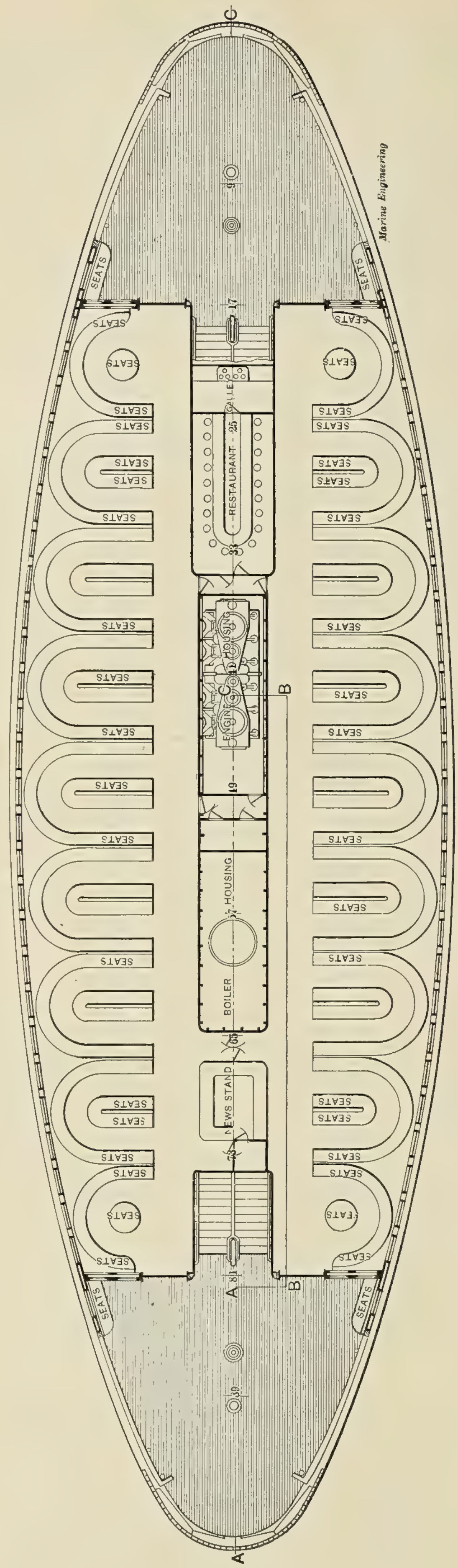
of 7 feet 3 inches at the side and 7 feet 6 inches in the middle of the vessel. There are two pilot houses, located one at each end on top of the saloon deckhouse. These are each 12 feet long by 10 feet 6 inches wide, and give a clear head-room of 7 feet.

On the main-deck, in one end of the cabin, will be a news stand finished in mahogany, with necessary racks and shelves. Extending along the center line of the vessel will be light and ventilating shafts for boiler room and engine room, a restaurant and galley, and a barber shop, it being estimated that a man will have just about time for a shave during the passage.

One peculiar feature about these boats is that teams will not



LONGITUDINAL SECTION A, B, C.

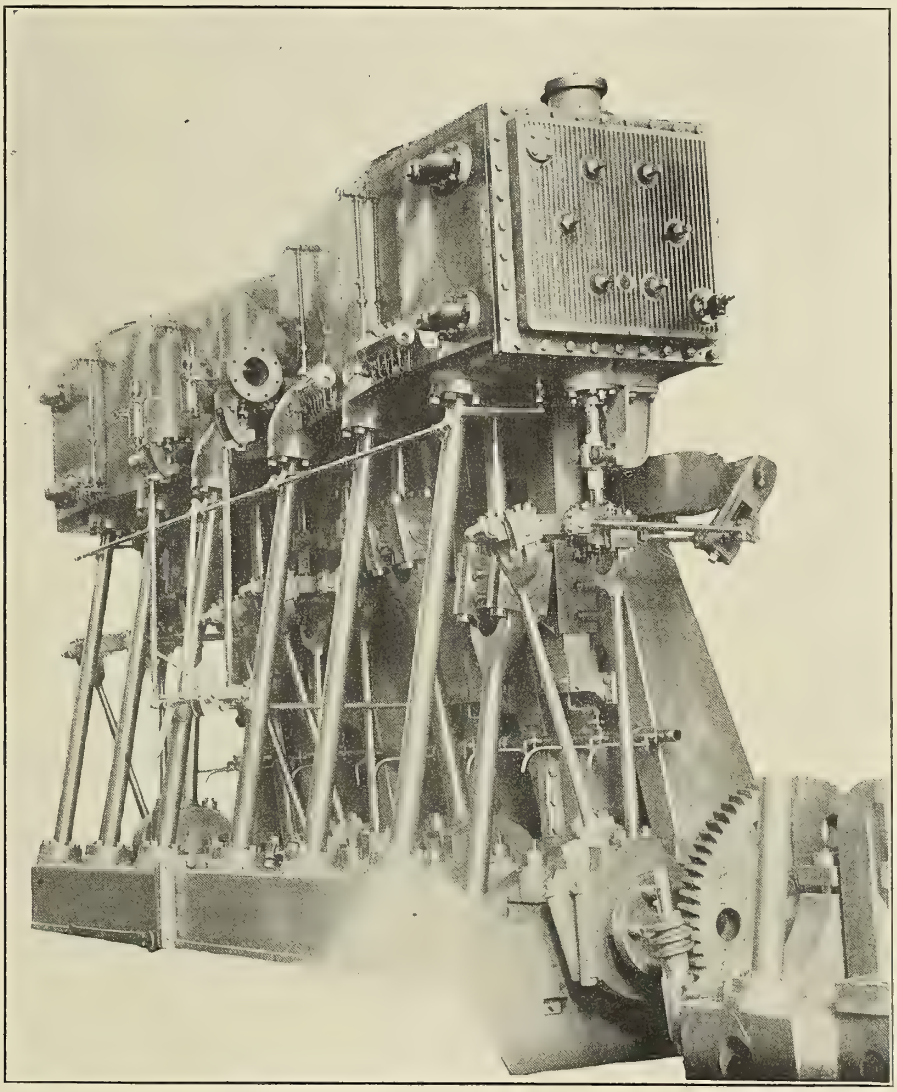


MAIN DECK

be carried, provision being made simply for passengers. This has resulted in an odd arrangement of the seats, as shown by the main-deck plan. The saloon-deck has just the same arrangement of seating as has the main-deck.

There is one engine in the form of a double-compound engine, having two high-pressure cylinders 20 inches in diameter, and two low-pressure cylinders with a diameter of 42 inches; all having a common stroke of 28 inches. This engine actuates a shaft carrying a screw at each end of the ship. The engine will be operated under a working pressure of 160 pounds per square inch at the throttle, at which pressure it will run at about 150 revolutions per minute. This gives a piston speed of 700 feet per minute. The indicated horsepower at full speed will be about 2,000. The pistons are cast steel, conical in shape, and fitted with cast-iron packing and bull-rings. The followers are also cast steel. The piston rods are machinery steel forgings 4 inches in diameter. Stuffing boxes for piston rods and valve stems are fitted with Katzenstein metallic packing. High-pressure valves are of the piston type, 10 inches in diameter, and single-ported. The low-pressure valves are balanced, double-ported slide valves made of cast iron. The valve gear is of the Stephenson type, with double bar links, all valves being worked direct. Connecting rods are of machinery steel, and are 70 inches long between centers. The shaft is of forged machinery steel, 8 1-2 inches in diameter for the intermediate sections and 9 inches for the tail sections. The propellers are two in number, of manganese bronze, four-bladed, with a diameter of 9 feet 9 inches, and a pitch of 12 feet 6 inches; giving a pitch-ratio of 1.29. The approximate blade area is 35 square feet, this providing ample surface for a rapid acceleration of the boat.

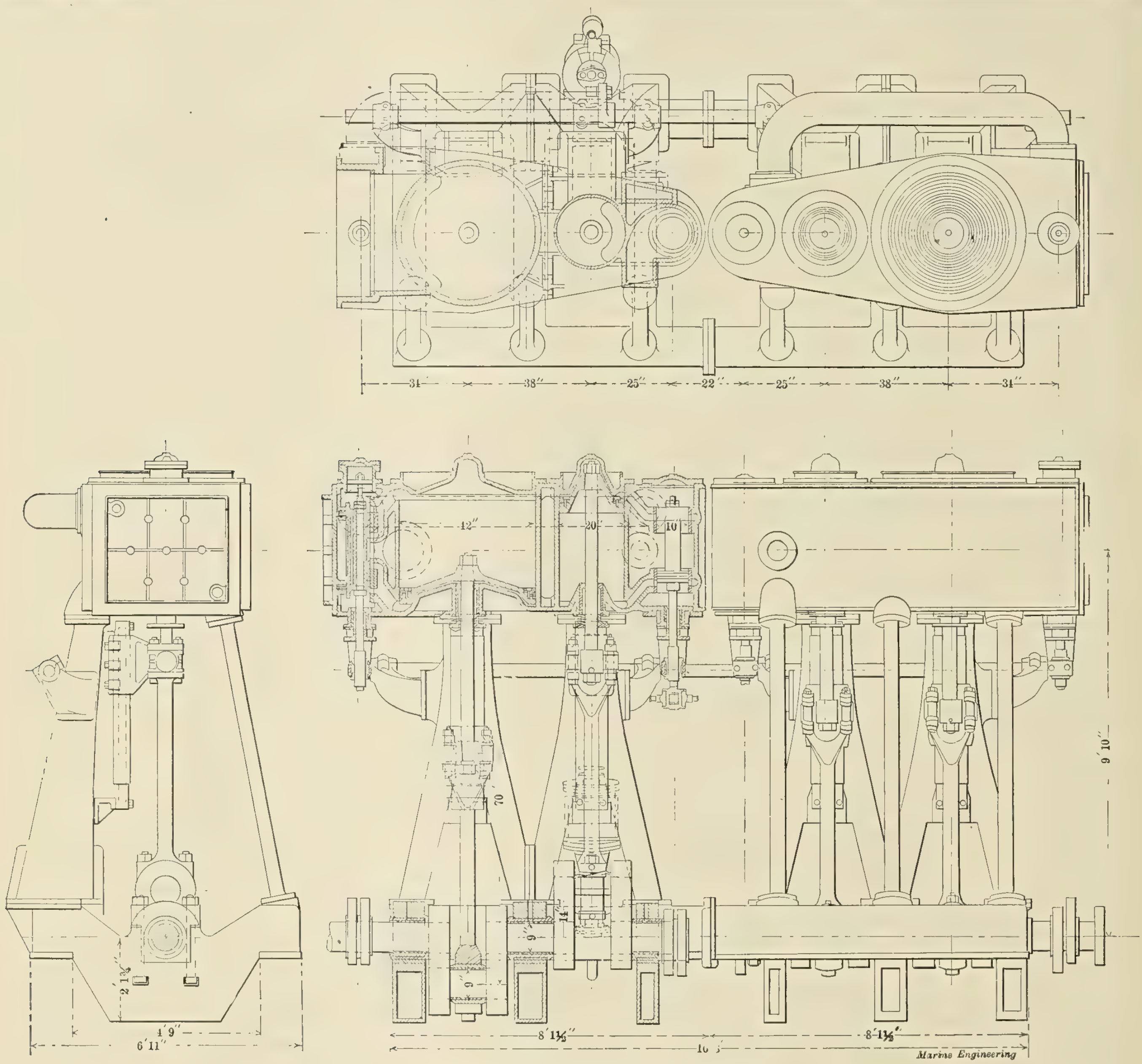
The two boilers are of the Babcock and Wilcox type, designed for a working pressure of 200 pounds per square inch, each being 10 feet 1 inch long, 16 feet 1 inch wide, and 12 feet 8 inches in height. The length of the steam drum, including its heads, is about 17 feet 6 inches. The tubes are of 2-inch and 4-inch diameter, the former having a thickness represented by No. 10 B. W. G., and the others, No. 6 B. W. G. The steam and water drums are 42 inches in diameter, and are made of open-hearth steel plates 1-2 inch in thickness. The drum heads have a thickness of 9-16 of an inch. The stack extends 48 feet above the main-deck, and is doubled, having an inside shell 68 inches in diameter, and constructed of No. 10 steel, and an outside shell of No. 12 steel 80 inches in diameter. It is stayed by six galvanized steel wire-rope guys 2 inches in circumference. There are a pair of Blake vertical simplex pumps, having steam cylinders 12 inches in diameter, water cylinders 7 inches in diameter, and a common stroke of 12 inches. The water cylinders are to be tested to a pressure of 300 pounds per square inch. For fire protection, a Blake horizontal duplex pump is fitted, having steam and water cylinders 10 inches and 7 inches respectively in diameter and 12-inch stroke. The circulating pump is centrifugal with 12-inch suction and discharge pipe, and is driven by a compound engine with cylinders 5 and 10 inches in diameter and 8 inches stroke. The air pump is a Blake, single-acting, twin vertical pump, with



THE ENGINES OF THE FERRYBOAT SAN FRANCISCO.

two steam cylinders 9 inches in diameter and two air cylinders 18 inches in diameter, with a stroke of 12 inches.

The boilers are fitted for burning fuel oil, which is carried in two tanks, as shown in the inboard profile. This oil is pumped to the furnaces by a double pumping system consisting of two Blake horizontal duplex pumps, having steam cylinders and oil cylinders, respectively, 4 1-2 inches and 2 3-4 inches in diameter, with a common stroke of 4 inches. Steam will be used for atomizing the oil. The oil tanks are each 6 feet in diameter and 12 feet in length constructed of steel 5-16 inch in thickness. The combined capacity is about 5,000 gallons.



THE ENGINES OF THE FERRYBOAT SAN FRANCISCO.

The boats are lighted by electricity generated by two direct-coupled sets each having an output of 15 kilowatts at 400 revolutions and 110 volts. An automatic governor is to be fitted so that a variation of 25 percent in the load will not affect the speed of the engine more than 2 percent. There will be about 360 lamps, nearly all of 16 candlepower, and required to develop 1 candlepower for each 3.1 watts furnished.

The hull and joiner work have been constructed by John W. Dickie, of San Francisco; the boilers at the Bayonne shops of the Babcock & Wilcox Company; and the engines and shafting by John W. Sullivan, of New York. The boats will be ready for a trial trip early in March.

Ocean Yacht Race.

The Kiel Yacht Club has set May 15 as the date for the beginning of the ocean yacht race for the cup which the emperor of Germany has offered. No restriction as to nationality is provided, but all boats competing must have a tonnage of at least 200. There are only four or five German yachts which fulfill this tonnage requirement, of which two belong to the emperor himself, one being the *Meteor III.*, which was built in the United States a few years ago.

The management of the race on this side of the ocean will be conducted by the New York Yacht Club. It is expected that several American yachts will enter the competition, and also that some English, and possibly one or two French, yachts will compete. There has been some talk of changing the rig of the cup defender *Columbia*, so that she will be able to enter a race of this character. There is some idea that if this were done she would stand a very good chance of coming in near the head.

The emperor's idea is to get American yachts to the other side in order to institute comparisons between them and German yachts, and thus give something of a boom to yacht racing in German waters. It is reported that several American yachts are already entered.

PRACTICAL POINTS ABOUT THE SCREW PROPELLER.

BY W. F. DURAND.

PART III. DESIGN.

The problem of propeller design is concerned primarily with the determination of such dimensions, form, and proportions of propeller as shall best fulfill certain specified purposes, the latter being stated in terms of some combination of power, speed, and characteristics of the ship. The usual data which are furnished as points of departure are speed and power, and the design is commonly based on these two items, with such additional aid as may be derived from a knowledge of the ship. It results that in all formulæ and methods commonly employed for this purpose, horsepower and speed are primary items, combined with the controlling features of the propeller and of its operation. Where the constants employed in such formulæ are based on experimental determination, and where the formula or method is intended to take account of all the important controlling items which may enter into the problem, such method is undoubtedly the most suitable, providing as it does for such detailed analysis of the probable performance as the data in hand will permit of making, and for due recognition of the various items which may enter as factors into the final result. It is safe to say, however, that actually but few propellers are designed with reference to such detailed analysis, and that most of the formulæ which have been used for these purposes are admittedly quite approximate in character, and must of necessity contain a large element of judgment. There is always room for a formula or method of this approximate character, especially if it is reasonably simple in use and if it provides at the same time for some approximate recognition of the effects due to the principal variable items on which the performance as a whole will depend.

With these purposes in view the method of design given in the present chapter has been developed. It should be understood at the start that this method is not offered as a substitute for those of a more detailed character and including more complete recognition of the various items, but rather as a convenient and simple method for the guidance of those who are not experts in this field of design, but who may wish to determine the dimensions of a screw propeller with some assurance of a reasonably satisfactory result.

In proceeding with the development of the method we may first call attention to the fact that within the usual limits of admissible error we may assume the I. H. P. required for the propulsion of the ship to vary as the cube of the speed, especially with the provision of a corrective factor for controlling departures from this general law. Furthermore, it will be found that in all propeller formulæ, however disguised, the power absorbed by the propeller is assumed to vary likewise as the cube of the speed. Accepting these relationships it should be possible to eliminate the item of power, and to thus develop a relation directly between the functions of the ship and those of the propeller on which the item of power depends. This would result in relating the propeller directly to the ship and independent of the power, except indirectly, as will later appear. That such a direct relation between the propeller and the ship is reasonable may also be seen by remembering that the same propeller must in fact be used often over a wide range of power and speed, and that if well designed it will operate over such range with but slight variation in efficiency. It is again reasonable when we remember that in effect it is the resistance of the propeller which overcomes the resistance of the ship. The propeller is rotated at the stern of the ship, the blades meet with resistance to their motion, and the fore-and-aft component of this resistance furnishes the propulsive thrust. There is therefore a balance between the resistance of the ship and the fore-and-aft component of the resistance of the propeller, and such being the case it seems reasonable to assume that the size of the propeller may be directly related to the size of the ship, the details of the relationship being made to include such special items of the case as the data in hand will permit. A further reason for the convenience of a formula of this character is found in the fact that oftentimes, especially with the non-expert designer, the size of the ship or boat is known independent of the power or speed. The problem is simply one of fitting to a given ship or boat a propeller such that whatever the power it will be economically absorbed for propulsive purposes, and such speed realized as may properly be expected under the conditions.

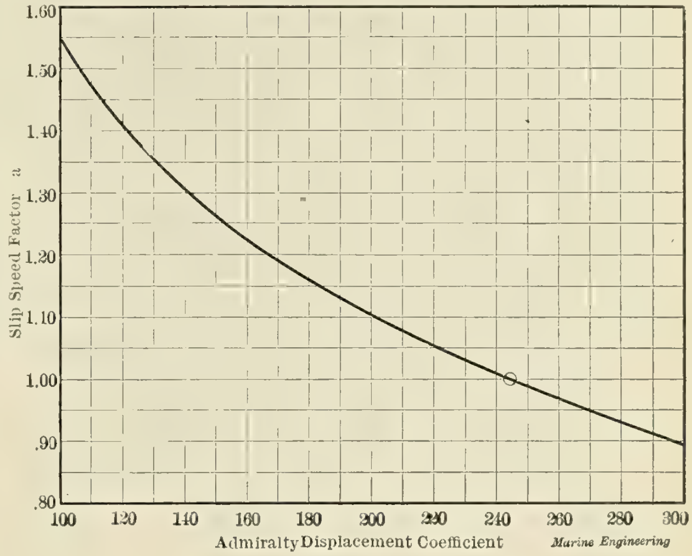


FIG. 34.

With this, by way of general explanation, we will state the formula at once, and proceed with its discussion by means of illustrative problems.

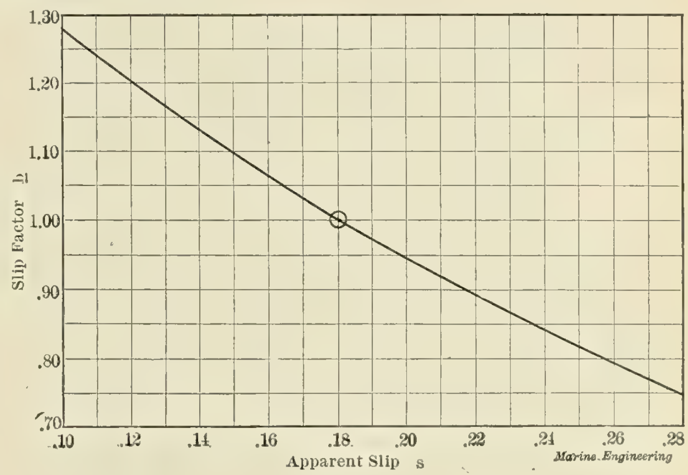


FIG. 35.

Let D = displacement of ship in tons, or in case of twin or triple screws, total displacement divided by number of shafts.

u = speed of ship in knots.
v = speed of ship in miles per hour.
d = diameter of propeller in feet.
p = pitch of propeller in feet.
N = revolutions per minute.
a = ship-speed factor derived from Fig. 34.
b = slip factor derived from Fig. 35.
c = pitch-ratio factor derived from Fig. 36.
e = area factor derived from Fig. 37.
s = apparent slip-ratio.

Then we have:

$$d = abce\sqrt[3]{D} \qquad (1)$$

$$N = \frac{101.3u}{p(1-s)} \text{ or } \frac{88v}{p(1-s)} \qquad (2)$$

$$s = \frac{pN - 101.3u}{pN} \text{ or } \frac{pN - 88v}{pN} \quad \ldots\ldots (3)$$

Again, let d = diameter of propeller in inches.
W = displacement of boat in pounds, or total weight in pounds, of boat and load in normal condition.

Then we have:

$$d = .9abce \sqrt[3]{W} \quad \ldots\ldots (4)$$

where a, b, c, and e have the same meaning and values as in (1).

The fundamental equation (1) means simply that the diameter of the propeller is equal to the cube root of the displacement in tons, multiplied by a combination factor a, b, c, e, which, as explained later, is to be derived from the special condition of the case. The diameter being thus determined, the pitch, revolutions, and surface area will directly result from the various assumptions required for the determination of the factors b, c, and e. On the other hand, if the diameter, pitch, or revolutions are fixed, some one of the factors b, c, or e is left to be determined by the fundamental equation, and the possibility of a satisfactory solution with the assumed values is determined by the resulting value of such factor. These various points will be made clear by means of illustrative problems to follow.

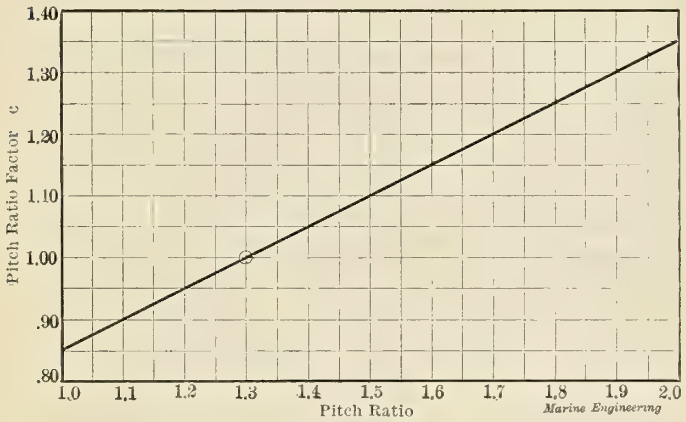


FIG. 36.

We must first, however, discuss briefly the nature of the factors a, b, c, e.

The ship-speed factor a is intended to take account of the dimensions and form of the ship, especially in relation to the expected speed. To those familiar with the subject of ship powering, it will be sufficient to state that this factor represents the Admiralty coefficient K, in the well-known formula $H = D \quad u^3 \div K$. The value of K which corresponds to the value of $A = 1$ is 242, while the lower limit of about .9 corresponds to 300, and the upper limit of 1.55 corresponds to 100. The values of this factor are in effect $\sqrt{242 \div K}$, and with this general explanation those familiar with common or appropriate values of the Admiralty coefficient will be able to readily select a correspondingly suitable value for the factor a. To those not thus familiar, some indications may be given as a general guide.

For any given ship, speeds measured in knots decidedly greater than the square root of the length in feet, may be called high or excessive. Where the speed is not much in excess of the square root of the length in feet, or when it is less than such square root, it may be considered as moderate or low. Thus, for a boat 100 feet in length, 10 to 12 knots is moderate speed, 15 to 20 or above high to excessive. For 400 feet in length, 20 knots is moderate, 25 high. With this understanding, ships of fair size, not too full in form, and at speeds not much exceeding the square root of the length in feet, will show a value of a close about unity. For larger ships or more moderate speeds, and in general under conditions favoring high propulsive efficiency, the values will fall through the lower range to about .90, or in rare cases slightly below. On the other hand, with smaller craft or full forms, and at high or excessive speeds, the values will rise through the higher range. For very fine forms, and such excessive speeds as are found with torpedo boats and very fast yachts, the values are usually lower than might be anticipated from the relation of the speed to the square root of the length in feet. Experience alone, or still better, experience combined with a proper use of the so-called "law of comparison," can best serve to safely select values for this coefficient, but representative values may be suggested in classes as follows:

CLASS.	VALUES OF a.
Launches and small craft at relatively high speeds	1.2 to 1.5
Small yachts at moderate to high speeds	1.15 to 1.4
Large yachts at moderate to high speeds	1.0 to 1.2
Cargo steamers, low to moderate speeds	.90 to 1.0
Large passenger steamers, high speeds	.95 to 1.0
Battleships and cruisers, high speeds	1.0 to 1.1
Torpedo boats and fancy yachts, excessive speeds	1.10 to 1.2

The slip factor b is intended to provide for the increasing thrust which is obtained with increasing slip, and the consequent reduction in the diameter of the propeller. The slip is one of the conditions which must be assumed in the solution of the problem, and the value first assumed must often be modified in order to finally reach a satisfactory adjustment of the result with the various special conditions of the problem.

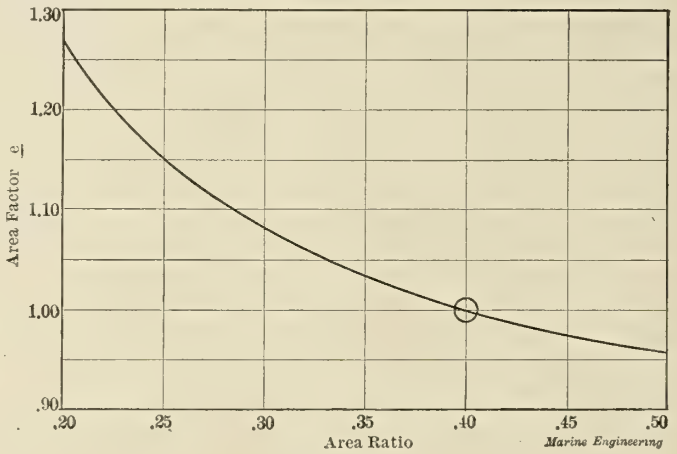


FIG. 37.

It should be noted at this point that by the term *slip* we here mean the so-called "apparent" slip as defined by equation (3). Due to the influence of the following wake in which the propeller works, the true slip is always greater than the apparent, but for simplicity we have here included reference to but one slip, and have expressed the factor b in terms of the apparent slip as most serviceable for the purposes in present view. This simplification has involved the assumption of a standard or average value of the wake influence which is supposed to apply to all cases, and of numerical value as determined by an average wake velocity of about .10 u, or 10 percent of the speed of the ship. It may be noted in this connection that while an error in the assumed value of the wake may modify appreciably the characteristics of the propeller resulting from the equations, yet the loss in actual efficiency will usually be small, and for most cases within our present purposes the average value may be safely assumed to apply, and the slip factor thus expressed in terms of the apparent slip as given in Fig. 35.

The pitch-ratio factor c is intended to take account of the fact that the higher the pitch-ratio the lower the thrust, other things being equal, and therefore the greater the necessary diameter of propeller. The selection of the pitch-ratio in any given case is often simply a matter of arbitrary choice, and the value first selected may require readjustment either to bring the revolutions within the desired range of values, or to make possible a satisfactory result on a specified diameter. Illustrations of the use of this factor will be given at a later point.

The surface-area factor e is intended to provide for the slowly increasing thrust with increase of area. The standard form of blade assumed is supposed to be elliptical or oval in contour, and the standard developed or surface area is taken as .40 of the disk area of the propeller. For such area the value of the factor e is 1, while for other values of the area-ratio the values are as given by the diagram in Fig. 37. Detailed investigation of the influence due to area shows that it depends on pitch-ratio and on slip, but for simplicity the indications of Fig. 37 are confined to average values of the slip, and are intended to apply more especially to values of the pitch-ratio, about 1.3. In all cases the same generally oval form of blade is assumed. If the blade was made broader at the tip the factor e might be taken somewhat smaller, but experimental results are lacking with reference to definite values of this influence.

With regard to the area-ratio, we may here indicate its usual values for propellers of 2, 3, and 4 blades:

Let d = diameter of propeller.
A = total developed area of blades.

Then area-ratio $= A \div \left(\frac{\pi d^2}{4}\right)$.

For 2 blades, area-ratio is usually found between .20 and .25
" 3 " " " " " " " .30 " .40
" 4 " " " " " " " .35 " .50

We will now proceed to the illustration of the use of these equations, by means of several illustrative problems:

(1) Given D = 1,500 tons.
Type, large yacht.
Propeller, one, 4 blades.
Speed, 16 knots.
Assume factor a = 1.05.
Take trial slip = .18 and pitch-ratio = 1.3.
Then factor b = 1.00
and factor c = 1.00.
Assume also standard area.
Then factor e = 1.00.
We then have immediately:

$$d = 1.05 \sqrt[3]{1,500} = 1.05 \times 11.45 = 12 \text{ feet.}$$
$$p = 1.3 \times 12 = 15.6 \text{ "}$$
$$N = \frac{101.3 \times 16}{15.6 \times .82} = 126.7$$
$$\text{Area} = .40 \times 113.1 = 45.24 \text{ sq. ft.}$$

Such a propeller could then be reasonably expected to develop 16 knots on 126.7 r. p. m., or any proportional speed on approximately corresponding revolutions, and in general to efficiently do its part in the attainment of any speed of which the boat and power provided will permit.

(2) Suppose in problem (1) that higher r. p. m. are considered desirable for the engine, but without fixing any definite value. Such change in the r. p. m. may be brought about either by a decrease in the pitch-ratio, or diameter, or both.

To this end let us assume as follows:

Factor a as before = 1.05.
Slip = .22.
Pitch-ratio = 1.1.
Then b = .89.
c = .90.
Take e as before = 1.00.

Then we have:

$$d = 1.05 \times .90 \times .89 \times \sqrt[3]{1,500} = 9.63 \text{ feet.}$$
$$p = 1.1 \times 9.63 = 10.6 \text{ "}$$
$$N = \frac{101.3 \times 16}{10.6 \times .78} = 196$$
$$\text{Area} = .40 \times 72.8 = 29.1 \text{ sq. ft.}$$

Intermediate values will, of course, give intermediate results. These two problems thus represent two widely different solutions of the same case, either of which would presumably give satisfactory results, assuming, of course, the necessary I. H. P., and engines corresponding to the r. p. m. in each case.

(3) Given D = 7,600 tons.
Type, coasting, cargo, and passenger steamer.
Speed, 15.5 knots.
Propeller, one, 4 blades.
Take factor a = .96.
Take trial slip = .20 and pitch-ratio = 1.4.
Then b = .94.
c = 1.05.
Take e = 1.00.

$$\text{Then } d = .96 \times .94 \times 1.05 \sqrt[3]{7,600} = 18.63 \text{ feet.}$$
$$p = 1.4 \times 18.63 = 26.08 \text{ "}$$
$$N = \frac{101.3 \times 15.5}{26.08 \times .80} = 75.2$$
$$\text{Area} = .40 \times 272.6 = 109 \text{ sq. ft.}$$

The revolutions in this solution are quite moderate, and if it is desired to reduce the diameter, such reduction may be accomplished by a reduced pitch-ratio and increased revolutions. Thus, assume pitch-ratio = 1.3, and also area-ratio about .45.

Then we have in this case:

a = .96
b = .94
c = 1.00
e = .98

$$\text{and } d = .96 \times .94 \times .98 \sqrt[3]{7,600} = 17.4 \text{ feet}$$
$$p = 1.3 \times 17.3 = 22.6 \text{ "}$$
$$N = \frac{101.3 \times 15.5}{22.6 \times .80} = 86.9$$
$$A = .45 \times 238 = 107 \text{ sq. ft.}$$

A still further reduction might, of course, be made in the diameter by assuming a higher value of the slip with its reduced value of the factor b.

(4) Given D = 14,000 tons.
Type, armored cruiser.
Propellers, two, 3 blades each.
Speed, 22 knots.
Assume a = 1.00.
Take trial slip = .20, and pitch-ratio = 1.3.
Then b = .94
c = 1.00
Take e = 1.00

Then we have:

$$d = .94 \sqrt[3]{7,000} = 18.0 \text{ feet}$$
$$p = 1.3 \times 18 = 23.4 \text{ "}$$
$$N = \frac{101.3 \times 22}{23.4 \times .80} = 119$$
$$\text{Area} = .40 \times 254.5 = 101.8 \text{ sq. ft.}$$

A somewhat different and possibly more satisfactory propeller may be developed by taking a lower pitch-ratio and lower slip. Thus, let us take pitch-ratio = 1.2 and slip = .18, the other factors remaining as before. We then have:

a = 1.00
b = 1.00
c = .95
e = 1.00

$$\text{and } d = .95 \sqrt[3]{7,000} = 18.17 \text{ feet}$$
$$p = 1.2 \times 18.17 = 21.80 \text{ "}$$
$$N = \frac{101.3 \times 22}{21.8 \times .82} = 124.7$$
$$\text{Area} = .40 \times 259.3 = 103.7 \text{ sq. ft.}$$

If the diameter of this propeller must be decreased it may be done by increasing the slip and the revolutions. Thus, let us take the same values as in the last case except for the slip, which we will assume at .20. We then have:

$a = 1.00$
$b = .94$
$c = .95$
$e = 1.00.$

$$\text{Then } d = .94 \times .95 \sqrt[3]{7,000} = 17.1 \text{ feet}$$
$$p = 1.2 \times 17.1 = 20.5 \text{ "}$$
$$N = \frac{101.3 \times 22}{20.5 \times .80} = 136$$
$$\text{Area} = .40 \times 230 = 92 \text{ sq. ft.}$$

(5) We will next vary the problem by assuming fixed revolutions:

Given $D = 460$.
Type, torpedo-boat destroyer.
Propellers, two, 3 blades each.
Speed, 28 knots.
Revolutions, 320.
Take $a = 1.20$
slip $= .17$
$b = 1.03$.

$$\text{Then } PN = \frac{101.3 \times 28}{.83} = 3,420$$

and $p = 3,420 \div 320 = 10.7$ feet.
Take pitch-ratio $= 1.35$.
Then diameter $= 10.7 \div 1.35 = 7.93$ feet
and $c = 1.025$.
Then:

$$7.93 = 1.20 \times 1.03 \times 1.025 \; e \sqrt[3]{230} = 7.77 \; e$$
$$\text{or } e = 7.9 \div 7.77 = 1.017.$$

This indicates an area-ratio of about .37, and hence:

$$\text{Area} = .37 \times 49.4 = 18.3 \text{ sq. ft.}$$

These values indicate a practicable solution along the assumed lines, and a well-proportioned resultant propeller.

(6) Given $D = 2,000$ tons.
Type, gunboat, single screw.
Speed, 16 knots.
Suppose diameter fixed at 12 feet.

Take $a = 1.04$
slip $= .16$
pitch-ratio $= 1.4$
Then $b = 1.06$
$c = 1.05$

Then we have:

$$12 = 1.04 \times 1.06 \times 1.05 \; e \sqrt[3]{2,000}$$
$$\text{or } 12 = 14.58 \; e$$
$$e = .82.$$

An examination of Fig. 37 clearly shows that this value of e is out of the question, and that in consequence the values assumed for slip and pitch-ratio must be recast. Let us therefore take new values as follows:

$a = 1.04$
slip $= .18$
pitch-ratio $= 1.15$
Then $b = 1.00$
$c = .92$

Then we have:

$$12 = 1.04 \times 1.00 \times .92 \; e \sqrt[3]{2,000}$$
$$12 = 12.06 \; e$$
$$e = .995.$$

This means practically the standard area-ratio of .40, and therefore indicates a practicable solution along these lines. We then have:

$$p = 1.15 \times 12 = 13.8 \text{ feet}$$
$$N = \frac{101.3 \times 16}{13.8 \times .82} = 143$$
$$\text{Area} = .40 \times 113 = 45.2 \text{ sq. ft.}$$

(7) Instead of the routine of problem (6) let us proceed as follows:

Take $a = 1.04$
$d = 12$ feet
pitch-ratio $= 1.10$
Then pitch $= 13.2$ feet
and $c = .90$
Take also $e = 1.00$.

This leaves the slip to be determined by the factor b. We then have:

$$12 = 1.04 \times b \times .90 \times \sqrt[3]{2,000}$$
$$12 = 11.79 \; b$$
$$b = 1.02.$$

This indicates a slip of about .17, and we have therefore:

$$N = \frac{101.3 \times 16}{13.2 \times .83} = 148$$
$$\text{Area} = .40 \times 113 = 45.2 \text{ sq. ft.}$$

(8) Let us take next a small boat with displacement given in pounds, and speed in miles per hour:

Let $W = 18,000$.
Type, launch.
Propeller, one, 4 blades.
Speed, 12 miles per hour.

Take $a = 1.4$
slip-ratio $= .20$
pitch-ratio $= 1.2$
Then $b = .94$
$c = .95$
Take also $e = 1.00$

Then we have from (4):

$$d = .90 \times 1.4 \times .94 \times .95 \sqrt[3]{18,000}$$
$$\text{or } d = 29.5 \text{ inches}$$
$$p = 1.2 \times 29.5 = 35.4 \text{ inches} = \text{say } 3 \text{ feet}$$
$$N = \frac{88 \times 12}{3 \times .80} = 440.$$

(9) Let $W = 8,000$.
Type, launch.
Propeller, one, 4 blades.
Speed, 18 miles per hour.
Take $a = 1.35$.
Assume d not to exceed 24 inches.
Take pitch-ratio $= 1.40$.
Then pitch $= 1.4 \times 24 = 33.6$ inches $= 2.8$ feet.
$c = 1.05$.
Also take $e = 1.00$.
This leaves slip to be determined by the factor b.
Then we have:

$$24 = .90 \times 1.35 \times b \times 1.05 \; \overline{8,000}$$
$$24 = 25.5 \; b$$
$$b = .941.$$

From Fig. 35 this implies a slip-ratio of about .20, and we have therefore:

$$N = \frac{88 \times 18}{2.8 \times .80} = 707$$
$$\text{Area} = .40 \times 452 = 181 \text{ sq. inches.}$$

(10) Let $W = 4,800$.
Type, launch.
Propeller, one, 2-bladed, reversible.
Speed, 8 miles per hour.

Take $a = 1.55$
pitch-ratio $= 1.30$
slip-ratio $= .22$
Then $b = 1.00$
$c = .89$
Take $e = 1.15$.

Then we have:

$$d = .9 \times 1.55 \times .89 \times 1.15 \sqrt[3]{4{,}800}$$
$$= 24 \text{ inches}$$
$$p = 1.3 \times 24 = 31.2 \text{ inches} = 2.6 \text{ feet}$$
$$N = \frac{8 \times 88}{2.6 \times .78} = 347.$$

The diameter may be reduced somewhat by a decrease of pitch-ratio and increase of revolutions.

Thus, with all other values the same, let us take pitch-ratio $= 1.1$, and hence $c = .89$. Then the diameter of the propeller will be reduced in the ratio of the two values of c or .89 to 1.00, and we have:

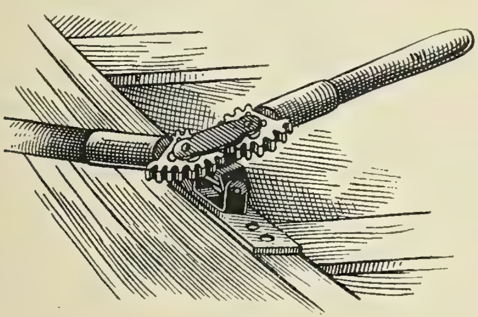
$$d = .89 \times 24 = 21.36 \text{ inches}$$
$$p = 1.1 \times 21.36 = 23.5 \text{ inches} = 1.95 \text{ feet}$$
$$N = \frac{8 \times 88}{1.95 \times .78} = 463.$$

Examples might, of course, be indefinitely multiplied, but the various cases here discussed will sufficiently serve to illustrate the principal problems which may arise in connection with propeller design, and the manner of their treatment by the method given.

It must not be supposed that any set of equations or printed directions can take the place of experience in propeller design, or can properly equip the amateur to confidently undertake all cases of such design with which he may come into contact. It is intended, however, to provide, by the above method, such guidance as shall best serve to direct the steps of those not familiar with the intricacies of the problem of propeller design, and at the same time to provide for those equipped with some measure of personal experience, a method of procedure simple and convenient in operation, and well adapted to the application of such individual judgment or experience as may be brought to bear on the case in hand.

Articulated Oar.

An ingenious invention, which may or may not be already known in the United States, is being talked about just now in the French journals. It is an articulated oar for row boats, which enables the rower to row his boat while facing in the direction in which he is moving instead of turning his back, as the old system requires. The inventor is M. Doyen, of 66 rue de Namur, Brussels, Belgium.



It is claimed for this invention that while permitting the rower to face in the direction in which he desires to propel the boat, it does not in any other manner affect the old system of rowing or weaken the effect of the stroke. Consequently, no training or practice is required to enable any oarsman to use the new oar. It is formed of two arms, which are joined at the oarlocks by articulating toothed sectors, which are firmly attached to the boat. This mechanism produces an inversion in the movement of the two arms of the oar. The cleats which join the two arms are so adjusted that the oarsman gives to the articulated oars the same movements of raising or lowering and of propulsion as with ordinary oars. The accompanying illustration gives an idea of the invention.—*Daily Consular Report.*

TELEPHONES ON THE GREAT NORTHERN STEAMSHIP MINNESOTA.

BY A. F. BOARDMAN.

The telephone system on this ship is said by the manufacturers to be the largest installation of the kind on shipboard. Its only equal will be the one now being installed in the sister ship, the *Dakota*, of the same company. The system here employed is of especial interest to the telephone man, but is, of course, of great interest to the marine man. There are two distinct installations: one, the general, which is a regular telephone exchange connecting the various state rooms with the steward's office. The other is a special system which connects the executive offices of the ship with each other. Both systems were furnished by the Electric Gas Lighting Company of Boston, Mass.

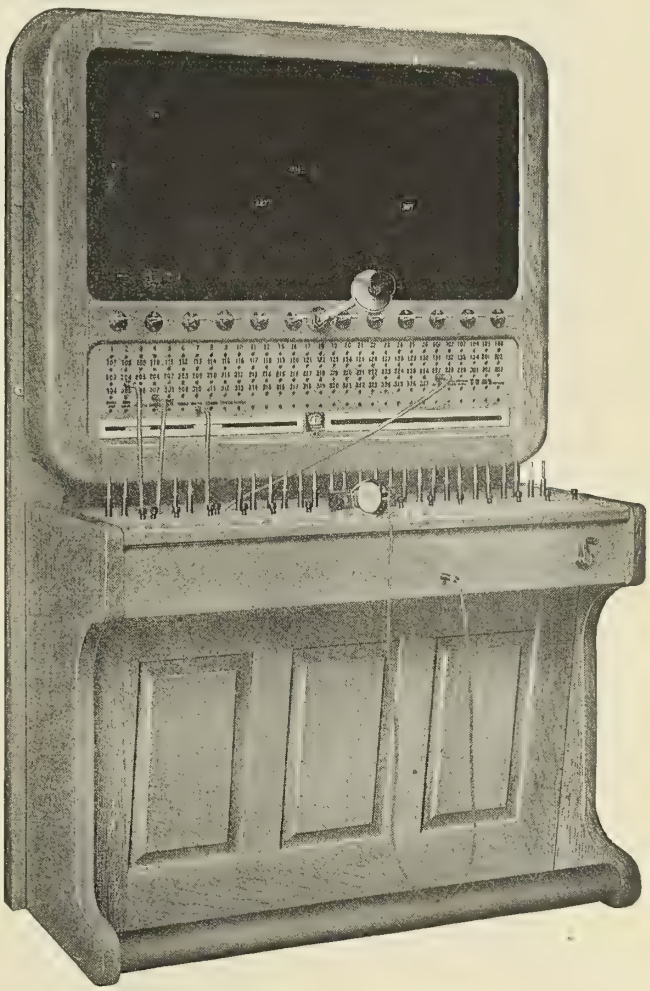


FIG. 1.—GENERAL SYSTEM SWITCHBOARD.

The switchboard of the general system is placed in a separate room in the after part of the vessel, and consists of a 150-line switchboard mounted in a light oak cabinet to match the general surroundings. Fig. 1 will give a good idea of the appearance of the switchboard. For the interest of those versed in telephony it may be stated that the system employed is what is known as a central energy system. The switchboard is a combination annunciator and telephone switchboard, which the manufacturers have given the trade name of "Annunciphone." The part of the instrument on which the signals are received is fitted with the regulation navy standard marine annunciator drop. This drop has peculiar advantages over the ordinary telephone signal in the fact that it cannot be shaken out of place by any movement of the vessel, or by any shock however severe, the electric current being the only means for displaying the signal. Below the signals are the telephone connections or "jacks." These jacks connect with each state room and by means of plugs connected by cords to the instruments enable the operator in charge to communicate with any state room at will.

Besides the instruments in the state rooms, telephones are installed in almost every part of the vessel, such as the captain's private state room, the ladies' drawing room, the smoking room, library, kitchen, pantry, steward's department, laundry, chief engineer's office, chief electrician's office, so that no matter what a passenger's wants may be, he can be connected with the department desired. To call the steward the passenger simply needs to push the button on the face of the telephone. The call is then received on the annunciator, as in an ordinary annunciator system, but if the passenger has a verbal communication to make to the steward, or anyone else, he pushes the button and at the same time lifts the receiver from the hook and places it to his ear. Pushing the button sends an electrical impulse into the annunciphone and causes the number of the room to "drop" and display itself on the face of the instrument. The operator in charge thereupon inserts one of the plugs shown into the jack corresponding in number to the room indicated. He is then in telephonic communication with the passenger and can answer his questions, or send a steward, or perform whatever other service is required Should the passenger wish to communicate with some other passengers, or with some of the departments on the ship, such as the laundry or the doctor, the operator at the switchboard, by inserting one of a pair of plugs into the jack corresponding to the passenger's room, and the other plug of the same pair into that of the room desired, can enable them to talk directly with each other. If it should be required, as many as four different rooms may be connected up together in this manner, so that four people can join in the conversation. When this conversation is finished and the talking parties hang up their receivers, a target in the slot below the switchboard indicates that that particular pair have finished talking.

FIG. 2.—WATER-TIGHT TELEPHONE FOR EXPOSED POSITIONS.

This switchboard is also provided with a jack for connection with outside lines, so that when in port any passenger on the ship can communicate through the switchboard with anybody on the regular city exchange on shore, or the captain of the vessel can communicate directly with the agents of the ship without leaving his cabin.

The telephone in the room, shown in Fig. 4, is a very neat looking instrument, and is said by the manufacturers to be the latest development in interior telephones. The instrument is flush except for the projecting mouthpiece. The exposed parts are of metal and finished in a dead black to match the hardware trimmings of the state room.

The navigating system is independent of the switchboard and is equipped with an entirely different sort of instrument. In this system the party making a call calls up the party desired directly by simply pushing the appropriate button and placing the receiver to his ear; he is then immediately in communication with the party desired.

The instruments on this system, where they are exposed to the weather or other detrimental conditions, are mounted in a heavy, brass, watertight case, as shown in the illustrations, Figs. 2 and 3. The instruments themselves are so made as to reduce to a minimum dangers from spray and rain, should the same enter the instrument while being operated. The use of telephones in this manner, where they form an important part of the navigating equipment of the ship, is quite an innovation, and these instruments are built in a manner never before employed in telephone construction. The exterior consists of a brass shell, to which is attached an iron conduit carrying the circuit wires. On the inside of the case is a ridge upon which a plate carrying the mechanism is fastened by means of screws. Between the plate and the ridge is placed a rubber gasket. The receiver cord is covered with a rubber tube and a rubber earpiece is provided for the receiver, on account of the noise or the rushing sound of the wind, and to keep out rain or sleet. The transmitter is made with an elbow mouthpiece arranged to prevent entrance of moisture. Another unique feature is the hook switch. The hook upon which the receiver hangs is a dummy support, the switch itself being shown to the right of the plate. It is operated by the cover, so that when the cover is closed the circuit of the telephone is open, and when the cover is open the telephone circuit is closed. An

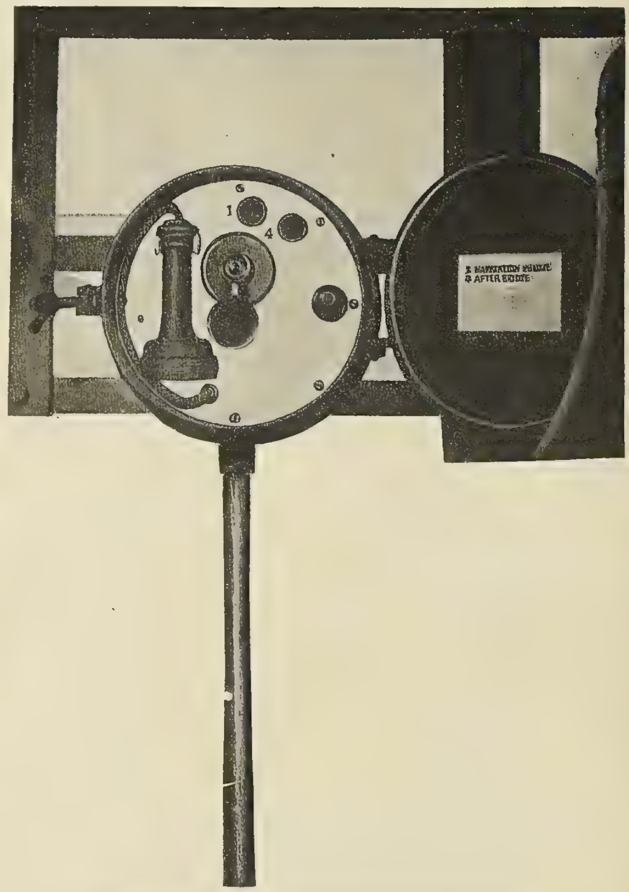
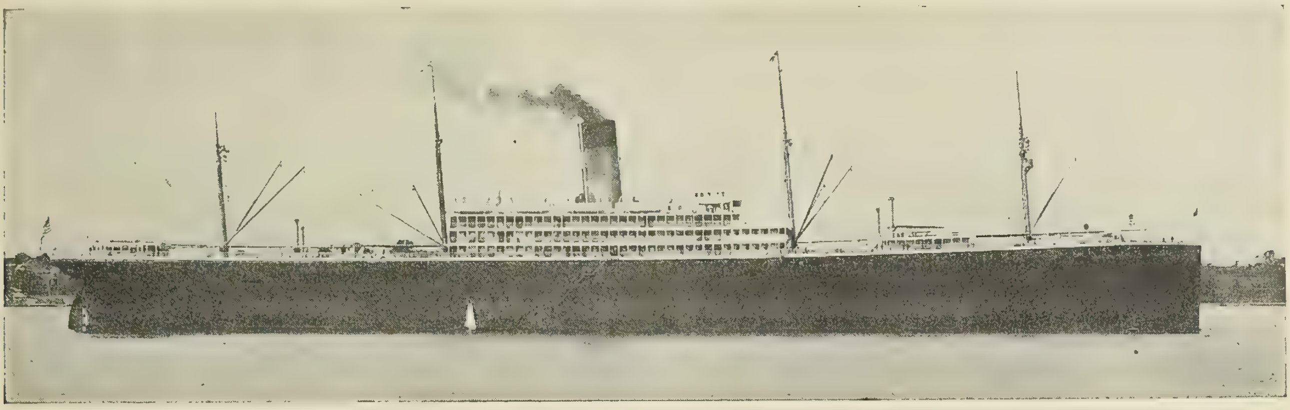


FIG. 3.—MARINE TELEPHONE ON FORWARD BRIDGE.



THE GREAT NORTHERN STEAMSHIP MINNESOTA.

interesting feature is the fastening mechanism which holds the cover to the front of the box. The pitch of the thread of the thumbscrew and locking bolt is made quite coarse, so that it can be rapidly unfastened and thus save time in the case of an emergency.

On the *Minnesota* the following stations are connected by this navigating system: the forward navigating bridge, main navigating bridge, after navigating bridge, port and starboard engine room, crow's nest, pilot house, chief engineer's office, chief electrician's room, central electric lighting station and dynamo room. The instrument shown in Fig. 3 is the one situated on the forward navigating bridge. This connects only with the main and after

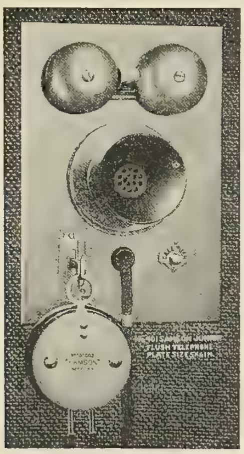


FIG. 4.—FLUSH METAL WALL TELEPHONE.

navigating bridges. One advantage of the system employed for the navigating plant is that each particular station can call only those stations which it is necessary in the course of his work for him to call. The navigating officer alone is able to talk to any of the eleven stations on this system. This can be varied to suit the requirements in any particular case.

The use of the telephone in the crow's nest is worthy of passing note. By its use the lookout is in immediate communication with the officer in charge, no matter what the weather is, and it will be understood by all that such a communication is much more sure than would be the case were he to have to call out his observations, as would otherwise be the case.

A 90,000-pound ingot, which is intended for the United States battleship *Vermont's* shafting, was recently cast at the National Steel Foundry Company, New Haven. The ingot is 50 inches in diameter and 13 feet long. To cast it the product of two 25-ton furnaces was required, and it took 35 minutes for the molten liquid to flow into the molds. Twelve other ingots of similar size are to be turned out by this company to form sections of the shafting of the battleships *New Hampshire* and *Rhode Island*.

POWERING SHIPS.

BY EDWIN CERIO, NAVAL ARCHITECT.

PART III.

V. ADDITIONAL RESISTANCES.

Usually when estimating horsepower only skin and wave resistance are considered; all residual resistances are implicitly comprehended in the latter, as in practice under wave resistance is understood the residual part of the total resistance after deducting that part due to friction. But in special cases, and whenever great accuracy is required, it is advisable to study separately the single additional resistances, the principal of which will be here analyzed.

(*a*) *Resistance Due to Irregularity of the Ship's Motion.* This depends upon the changes in speed and direction undergone by the ship in her progress. Propellers, as they are constructed up to date, are not able to secure a uniform motion, and this is the principal cause to which the additional resistance above mentioned must be ascribed.

(*b*) *Resistance Due to Stormy Sea.* This is also of such a nature that, like the preceding, it cannot be estimated *a priori* when designing a ship. Speed trials are in ordinary circumstances made in fair conditions of wind and sea; therefore stormy weather may be looked upon as an accidental cause of resistance not to be taken into account when powering the ship's engines. According to Durand, the influence of a stormy sea on resistance is less felt in a vessel when she has a considerable length, sufficient freeboard, is steady, and has large dimensions, consequently great weight.

(*c*) *Air Resistance.* In the first steamships this cause of resistance was negligible as compared to the importance it had in sailing vessels, but in modern ocean liners air resistance comes to be a considerable factor in the problem of powering ships, owing to the huge superstructures so common now in such craft. For a rough calculation the resistance of air may be taken into account as a percentage of the total resistance, but a more careful method is that of estimating it by means of formulæ. Calling Wa the air resistance and A the projected area of all exposed planes on a plane normal to the direction of motion, the general expression of this additional resistance is:

$$Wa = kAv^2.$$

This equation may be written in a more general way:

$$Wa = kA\,(V \mp V_1 \cos \alpha)^2.$$

Wa is given in pounds,
A in square feet,
V = speed of the ship, in knots,
V_1 = speed of the wind (if any), in knots,
k = 0.005.

The signs — and + to be employed according to the direction in which the wind blows. Air resistance varies with the square of the speed, while the principal resistances of a vessel in motion vary according to a higher power of the speed; therefore for great speeds this additional resistance due to air is of little importance as compared to skin and wave resistance. It assumes considerable values only when a strong wind is blowing against the ship, in which case it may sometimes as much as double the ordinary resistance. The formula given above is very useful to make corrections of the results obtained at trial trips carried out in stormy weather.

(*d*) *Resistance Due to Bilge Keels.* Bilge keels, and all other structures which in some points modify the ship-shaped forms of a vessel's hull, are apt to produce considerable changes in resistance; it is possible to appreciate the influence of bilge-keel resistance only by means of model experiments of ships similar to those which are to be designed. Very important researches on the influence of bilge keels were made at Spezia by Signor Rota of the Italian navy. A model of a battleship and one of a torpedo-boat destroyer were employed in a series of most important experiments, the results of which furnish the most reliable and exhaustive source of information on the subject. Table IX gives the dimensions of the vessels in full size:

TABLE IX.

Principal Data.	Battleship Sardegna.	32-Knot Torpedo Boat.
Length between perpendiculars.......... Ft.	410	229
Extreme breadth.......................... "	77.5	22.7
Mean draft.................................. "	28.6	5.05
Wetted surface (without bilge keels)............................ Square ft.	33,640	4,403
Displacement......................... Tons.	13,700	320

The accompanying diagrams (Figs. 6 and 7) show the increase of horsepower required when bilge keels are adopted, at a fixed speed. At a speed of the model of the *Sardegna,* corresponding to 16 knots of the ship in full size, the additional resistance was 2 percent, and at a speed corresponding to 22 knots the percentage was 5.5. In the *Sardegna* six additional bilge keels of varying dimensions were experimented with, the particulars of which are given in Table X.

TABLE X.—BILGE KEELS ON THE BATTLESHIP SARDEGNA.

Dimensions of Bilge Keels.	1	2	3	4	5	6
Length............	164′	197′	164′	197′	164′	197′
Breadth............	3′-3″$\frac{3}{8}$	3′-3″$\frac{9}{16}$	3′-3″$\frac{3}{8}$	3′-3″$\frac{9}{16}$	3′-3″$\frac{3}{8}$	3′-3″$\frac{9}{16}$
Height.............	1′	1′	1′	1′	1′	1′

The reduction of speed due to bilge keels, when employing the same horsepower, is shown in Table XI at the actual speed of the vessels without bilge keels.

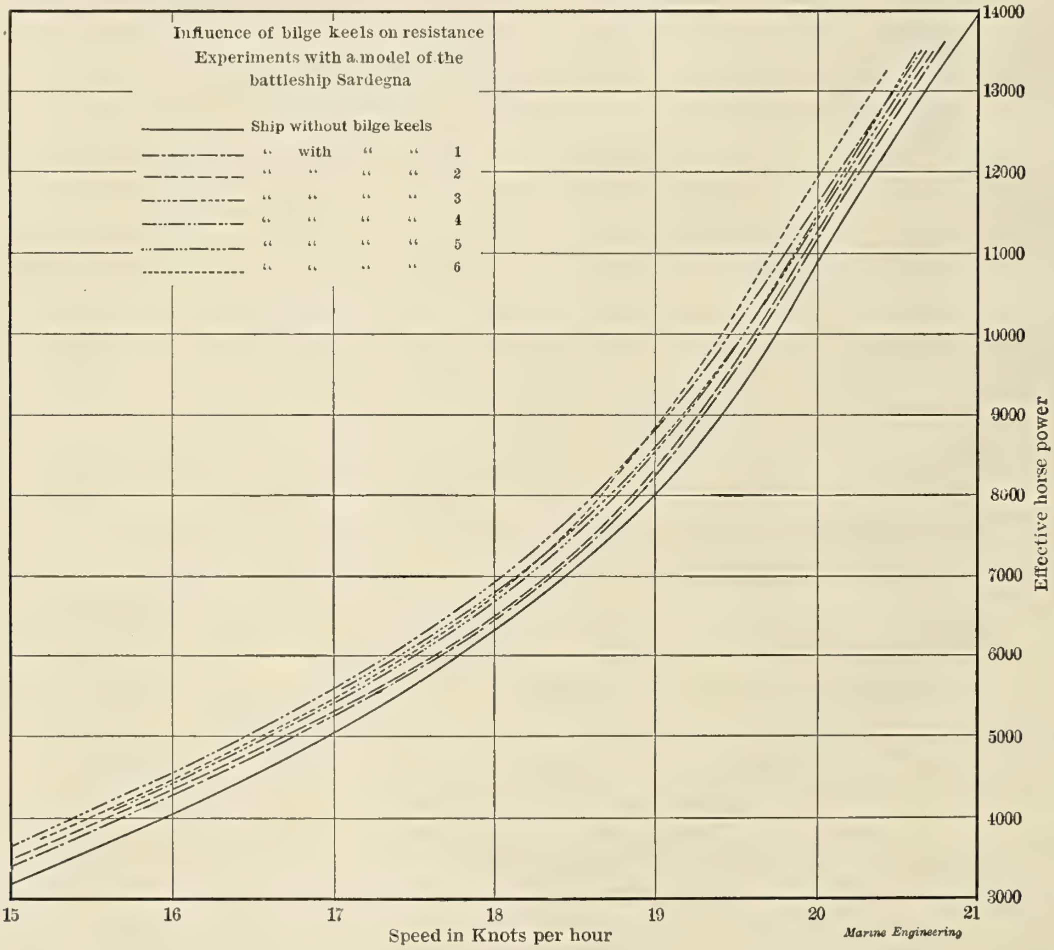


FIG. 6.

TABLE XI.—REDUCTION OF SPEED DUE TO ADDITIONAL RESISTANCE OF BILGE KEELS.

Ship.	Speed in Knots per Hour.						
	Without Bilge Keels.	With Bilge Keels.					
		No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Sardegna..................	20	19.92	19.88	19.84	19.77	19.82	19.70
Torpedo-boat destroyer..	32	31.62					

When designing a ship it will be always safe to consider an increase of at least 5 percent to the resistance if bilge keels are to be adopted.

(*e*) *Resistance Due to Shallow Waters and Limited Transverse Section of the Liquid Mass in which the Vessel Moves.* A characteristic of modern researches is the attention given to the influence of a limited depth of water on resistance; the navigation of a vessel in shallow waters, in a canal, or in the proximity of shoals and banks, produces a disturbance in the stream lines which are compelled to pass through a section of limited dimensions. Thus modified, the stream lines require an additional amount of energy to pass from the vessel to the water, and consequently an additional resistance is originated.

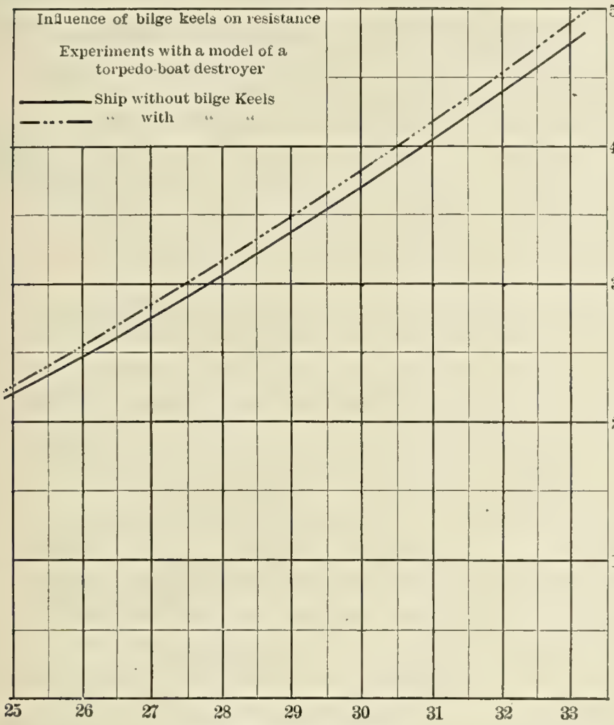


FIG. 7.

A remarkable example of the influence of shallow waters may be observed in the values of the Admiralty coefficient for the following warships at a speed of 20 knots:

	I. H. P.	C.
Gunboat *Sharpshooter*	3,500	186
Third-Class Cruiser *Medusa*	10,000	159
Second " " *Terpsichore*	9,000	198
First " " *Edgar*	11,000	276
" " " *Blenheim*	12,500	278

Except for the *Medusa*, the trials of these ships took place in very deep water; the *Medusa* trials giving such a low value of C were carried out in Stokes Bay, in which, as is well known, the depth of water is very limited, and where no more trials are now conducted by the British Admiralty.

Another instance illustrating the same fact is that of the U. S. S. *New York*, cited by Durand; in this vessel, when passing on a point where the depth of water was 37 fathoms, it was observed that the revolutions fell off and the steam pressure increased. Taylor has given the limits of depth at which the influence of the bottom produces no change of resistance, basing these limits only on the speed of the vessel. The results of Taylor's investigations on the distribution of steam lines have been obtained without taking into account the size of the vessel, and therefore the conclusions arrived at have no practical value. The question has been in the last few years thoroughly studied by Colonel Rota of the Italian navy.*

The diagrams contained in Fig. 8 have been worked out with the results obtained by model experiments carried out at Spezia, and show the depths required in order that the bottom may have no influence on the resistance. The models experimented with had the dimensions given in Table XII.

TABLE XII.

Dimensions.	Model No. 1	2	3	4
Length.......... Feet.	14.03	12.24	12.24	14.37
Breadth.......... "	2.59	2.13	1.87	1.52
Mean draft.......... "	0.92	0.68	0.68	0.53
Displacement.......... Pounds.	1069.2	555.5	488.3	354.1
Block coefficient..........	0.51	0.50	0.50	0.49

The results of the model experiments may be extended to full-size ships bearing any ratio of similitude to the models; Table

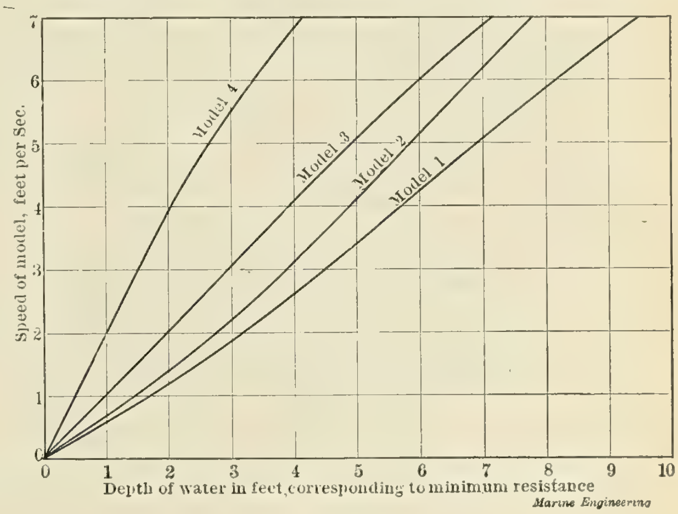


FIG. 8.

XIII is a rough application of such results to ships, varying from 12,000 tons to 1,000 tons in displacement, the limits of depth at which the influence of the bottom is no longer felt being given for speeds varying between 12 and 26 knots.

TABLE XIII.

Ship.	Corresponding to Model No. 1	2	3	4	4
Displacement....... Tons.	12,000	8,000	6,000	3,000	1,000
Length.......... Feet.	408	385	361	380	263
Breadth.......... "	75.5	67	55	40.3	28
Mean draft.......... "	26.6	21.4	20.2	13.8	9.6
	Minimum Depth in Feet for no Change in Resistance.				
Speed in Knots. 12..........	154	138	108	89	75
14..........	177	158	125	115	92
16..........	200	177	145	125	118
18..........	223	197	161	141	125
20..........	246	214	181	161	145
22..........	270	233	204	184	164
24..........	...	253	230	204	184
26..........	...	...	...	227	204

A ship navigating in a mass of water having a narrow transverse section, as is the case in the navigation of ships in canals

*Colonel Rota, the eminent authority in all matters connected with model experiments, has kindly put at my disposal the material of observations contained in his "Vasca, etc.," and other works in which the problem of resistance is investigated, and I wish to express to him my thanks for all the valuable information obtained through his kindness.

and rivers, experiences the influence of the disturbance in the stream lines, and the amount of power necessary for propulsion is much greater than that which she would require when navigating in a mass of water of practically indefinite section, as is the case of the open sea. Many experimental researches have been made to determine the resistance of ships in a canal; those conducted by Elnathan Sweet have led to the formula*

$$R = \frac{0.10303 \; sv^2}{r - 0.597},$$

where R = resistance in pounds,
s = wetted surface in square feet,
v = speed in feet per second,
r = ratio of section of canal to that of vessel.

Calling W' the resistance of a ship in a channel and W the resistance of the same in a mass of water of indefinite section, for speeds varying between 1 1-2 feet and 3 feet per second:

$$W' = \text{from 2 to 3 } W.$$

If a is the area of the transverse section of the vessel and A that of the channel, the ratio $\frac{W'}{W}$ grows with the speed and is indirectly proportional to the ratio $\frac{A}{a}$. From the experiments of de Mas† some conclusions of great importance may be drawn, such as those contained in Table XIV.

TABLE XIV.

$\frac{A}{a}$.	Values of $\frac{W'}{W}$ at a speed of:	
	1 Foot per Second.	4 Feet per Second.
8	1.00	1.20
5	1.40	2.20
3	2.60	5.80

Experiments by Rota lead me to conclude that the law of dynamical similitude cannot be applied to vessels navigating in canals as it is to those moving in water of unlimited section; this is evidently due to the fact that in the case of a channel, besides the resistance due to the skin-friction of the ship, the resistance generated by the friction of the banks and bottom of the channel ought also to be considered. This is not possible in practice, owing to the meager amount of data obtainable. In Fig. 9 a diagram is given showing the curves of resistance of the model of the river boat *Jeanne*‡ at different speeds and for different sections of canals.

Experiments were made to determine the influence of depth of water on the resistance of torpedo boats first by Capt. A. Rasmussen,** and lately in the German navy with a Schichau boat, the *S 119*, at Neukrug, near Danzig; the Baltic, in that part called the Frische Haff, where Neukrug is situated, presents remarkably favorable conditions for such trials as those carried out by Herr Marine Baumeister Paulus, who communicated the results to the Schleswig-Holsteinischer Bezirksverein Deutcher Ingenieure. As these results constitute a source of valuable and reliable information, we present the principal data obtained in these trials.

The *S 119* is the last boat built of a series of destroyers completed in 1903; she has the following characteristics:

Length at the water-line	207.60 ft.
Extreme breadth	22.96 ft.
Draft	8.86 ft.
Displacement	345 tons
Speed	30 knots
Indicated Horsepower	6,500

The trials in question took place in September, 1903, under uncommonly fair conditions of weather, and lasted a week; the measured mile was run 84 times at different depths of water, varying from a depth of 23 feet to one of 200 feet, beginning with the *minimum* depth and ending with the maximum, and *vice versa*

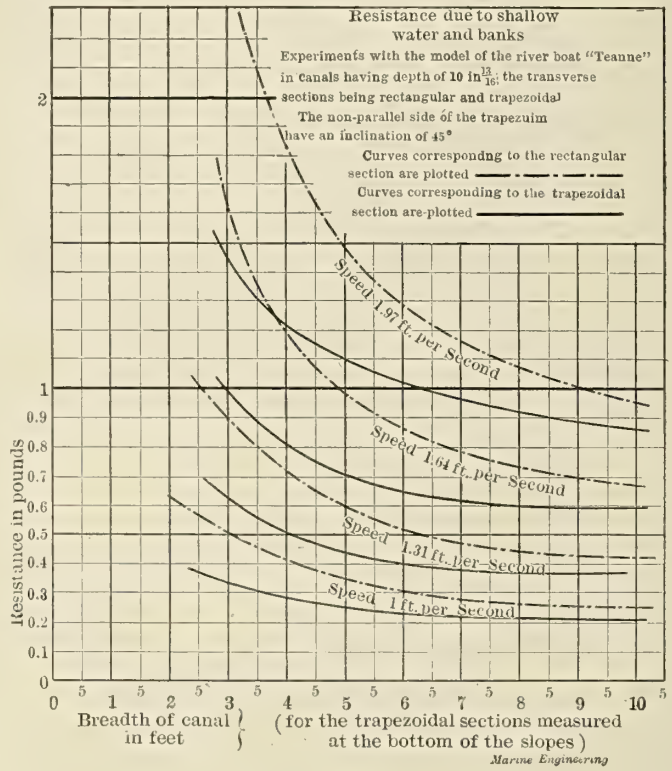


FIG. 9.

in the next series of runs. During the trials the speed, indicated horsepower, number of revolutions, trim, and wave configurations were measured with great exactness. Tables XV, XVI, and

TABLE XV.

IHP.	Speed at a Depth of:					
	200 Ft.	130 Ft.	82 Ft.	49 Ft.	34 Ft.	23 Ft.
5,680	27.17	26.93	26.55	27.20	27.66	27.82
4,600	25.13	24.86	24.56	23.58	25.50	25.95
4,000	24.01	23.73	23.46	21.80	23.52	24 52
2,700	21.48	21.28	21.09	20.00	17.75	15.84
2,000	20.00	19.84	19.72	19.08	16.94	15.11
1,500	18.75	18.67	18.58	18.20	16.68	14.84
1,000	17.16	17.16	17.06	16.86	16.22	14.44
500	12.2	12.2	12.2	12.2	12.2	12.2

TABLE XVI.

Speed.	IHP at a Depth of:					
	200 Ft.	130 Ft.	82 Ft.	49 Ft.	34 Ft.	23 Ft.
27 Knots	5.590	5.715	5,920	5,605	5,315	5,195
24 "	3.995	4,140	4,290	4,710	4,110	3,870
21 "	2,465	2.560	2,650	3,550	3,525	3,510
18 "	1,240	1,250	1,285	1,410	2,815	3,210
15 "	600	600	600	615	640	1,800
12 "	285	285	285	285	285	285

*Durand, "Resistance and Propulsion of Ships."

†Recherches expérimentales sur le matériel de la batellerie, par T. B. de Mas, Paris, 1891-97.

‡The reason the model of this ship was chosen is that the full-size vessel has already been the object of important experiments carried out by de Mas, the results of which are cited by Durand.

**Trans. of the Inst. of Nav. Arch., 1899. See also MARINE ENGINEERING, November, 1902, page 581; and April, 1903, page 202.

TABLE XVII.

Number of Revolutions.	Speed at a Depth of :					
	200 Ft.	130 Ft.	82 Ft.	49 Ft.	34 Ft.	23 Ft.
270	26.75	26.55	26.22	26.57	27.15	27.31
250	24.84	24.66	24.34	23.60	25.03	25.32
200	20.52	20.36	20.42	19.56	17.55	16.05
150	16.66	16.65	16.65	16.52	16.14	14.55
100	11.7	11.7	11.7	11.7	11.7	11.7

XVII contain the values of speeds for constant values of indicated horsepower, those of the indicated horsepower for constant values of the speed and the values of the speed for constant values of the number of revolutions, all these values being given for the different depths at which the experiments were carried out. Observing the results contained in the above tables, several important conclusions may be drawn, which apply to torpedo-boats in general and in particular to all ships bearing similitude to the one under experiment, necessary allowance being made for the difference in size, etc.

At a depth of 130 feet the influence of the bottom is not felt by torpedo-boats; at a speed of 27 knots the most unfavorable depth is that of 82 feet, as at this depth the decrease in speed is nearly 2 1-2 percent. At a speed of 12 knots, navigating at different depths of water, no increase in the indicated horsepower is noticeable.

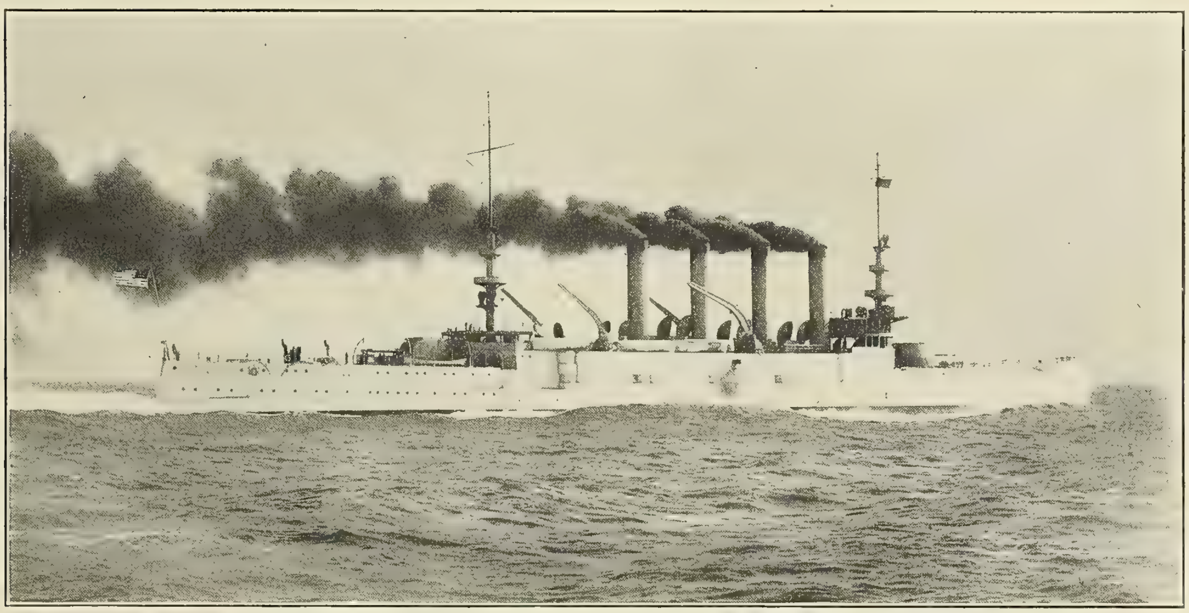
An instance proving the usefulness of comparison in problems of the kind of those here examined, is furnished by the Russian cruiser *Askold*. This vessel, built by Krupp at the Germania yard, Kiel, underwent her first trials in the Eckenfoerde Bay, under unfavorable conditions of depths of water; basing the comparison on Rota's model experiments, it was calculated that in deep water one-half mile would be gained in speed. This assumption was proved true by trials carried out at sea under the same conditions as those obtained in the Eckenfoerde trials.

There are still some other causes which increase the resistance of ships: for example, the slope of currents, etc.; but these are not of such importance as to be considered when powering ships, and therefore are not mentioned in this study.

(*To be concluded.*)

THE TRIAL TRIP OF THE ARMORED CRUISER MARYLAND.

On the 27th of January the new armored cruiser *Maryland*, under construction by the Newport News Shipbuilding and Dry Dock Company, was given a trial trip on a course extending for a distance of 44 knots from Thatchers Island off Gloucester to Cape Porpoise. The mean speed, without tidal correction, was figured out as 22.306 knots, and the tidal correction as computed added to this figure one-tenth of a knot, making the corrected speed 22.406. The indicated horsepower of the main engines is given as 27,571 and of the main engine and all auxiliaries 28,475. The coal consumed per square foot of grate figured out at 50.72 pounds per hour; that consumed per indicated horsepower of main engines was 2.872 pounds per hour, and the amount per indicated horsepower of all machinery 2.816 pounds. The air pressure in the fire-room was represented by 1.93 inches of water, the steam pressure being 300 pounds per square inch. This pressure was reduced at the engines to 250 pounds by means of special reducing valves, for the purpose of drying the steam and to a slight degree superheating it on its entrance into the high-pressure cylinder. The mean effective pressure reduced to the low-pressure cylinder was



THE UNITED STATES ARMORED CRUISER MARYLAND ON TRIAL.

51.76 for the starboard side and 52.35 for the port, giving a final mean of 52.055 pounds per square inch. The engines developed 128.5 revolutions per minute as the mean for the four-hour trial.

The *Maryland* is a steel armored cruiser with a displacement of 13,680 tons, having a length on the load water-line of 502 feet, a beam of 69 feet 6 1-2 inches, and a normal draft of 24 feet 1 inch. She was designed for a speed of 22 knots, which was to be developed by engines giving an indicated horsepower of 23,000 at 120 revolutions per minute. The coal supply is represented by 900 tons at the normal displacement, increased on full load to 2,024 tons. The full complement of officers and men numbers 41 and 787 respectively.

The twin-screw engines are placed in separate water-tight compartments and have each four cylinders measuring respectively 38 1-2 inches, 63 1-2 inches, and two of 74 inches diameter, with a common stroke of 48 inches. Steam is supplied by sixteen water-tube boilers of the Babcock and Wilcox marine type, placed in closed separate water-tight compartments. The total grate surface of the boilers is 1,600 square feet, and the heating surface

70,944 square feet; thus giving a ratio of heating surface to grate area of 44.34 to 1.

The main battery consists of four 8-inch breech-loading rifles mounted in pairs in turrets on the center line, forward and aft, and protected by 6 1-2 inches of armor; fourteen 6-inch rapid-fire guns mounted on the broadsides; eighteen 3-inch and twelve 3-pounder rapid-fire guns; besides eight 1-pounder automatic guns, six .30 automatic guns, two machine guns, two 3-inch field guns, and two 18-inch submerged torpedo tubes. The armor belt has a width of 9 feet, of which 5 feet is below and 4 feet above the normal load water-line. This belt is 6 inches in thickness at the top and tapers to 5 inches at the bottom. It further tapers at the stem and stern to a thickness of 3 1-2 inches.

Trial Trip of the Chattanooga.

The trial trip of the cruiser *Chattanooga,* which was mentioned in the February number of MARINE ENGINEERING, was carried out under somewhat different conditions than those which have obtained in the trials of nearly all of the ships in the United States navy. There were three sets of trials, consisting of standardization trials, a four-hour official speed trial, and a twenty-four hour endurance run at two-thirds power. In the first series, which took place on the 31st of December, the ship was run over the measured mile in Newport harbor for the purpose of determining the speed at different rates of revolution of the propellers. There were fifteen of these runs at revolutions varying from 60 to 180 per minute. In order to eliminate the effect of the tide, two runs were made at each speed, one in each direction.

The four-hour official speed trial was run on the 1st of January, and dependence was placed on the standardization trials for a record of speed. This method obviated the necessity of having a standard course marked by several stake boats, and also the necessity of keeping the ship in a perfectly straight course without reference to the movements of other vessels. The trial was reported to be a great success in every way, as the engines ran evenly and smoothly, and the boilers steamed freely, maintaining without difficulty the constant pressure of 265 pounds per square inch. The smoke is stated to have been very slight in quantity and very light in color. The principal results of the trial were:

Revolutions per minute of main engine	180.5
Speed of ship in knots	16.605
Indicated horsepower	5,390
Coal burned per hour per square foot of grate surface	35.4
Indicated horsepower per square foot of grate surface	18
Coal burned per hour per indicated horsepower, pounds	1.97

This coal consumption at full speed figures out at 4.74 tons per hour, or 113.7 tons per day, giving a steaming radius on the normal coal supply of 470 tons of 4 days and 3 hours, corresponding with a distance of 1,646 knots.

The twenty-four hour endurance run started on Monday the 2d of January in the midst of a terrific gale; after running for several hours in the teeth of this gale it was decided by the trial board that the capabilities of the ship and her machinery had been thoroughly proven, and the trial was discontinued.

Examinations for inspectors and assistant inspectors of hulls are announced for March 15 and 16, by the United States Civil Service Commission. The vacancies to be filled at once are one at Grand Haven, Mich., at $2,000; Cincinnati, Ohio, $1,200; Seattle, Wash., $1,500. The examinations are open to all American citizens between the ages of 25 and 55. Candidates should apply to the Commission, at Washington, for Forms 1087 and 1405.

A steam mud barge is in use on the Loire river, France. At present the river is at an extremely low level and the incoming tides deposit sand and mud. During the ebb tide the barge, which is fitted with a rake 36 feet long and weighing about 2 3-4 tons, is moved up and down the stream, dragging the bottom and loosening the silt, which is carried away by the tide.

EPOCHS IN MARINE ENGINEERING.*

BY GEORGE W. MELVILLE, REAR-ADMIRAL, U. S. NAVY.

To attempt to cover the history of marine engineering in a lecture which ought not to last much longer than an hour, would result in little more than a mere chronology and could not possibly be interesting. It seems much better, therefore, to give some consideration to the various periods or epochs in the history, considered with reference to the special inventions or changes which have characterized them. Many of these changes are clear examples of evolution, and others are instances of the adaptation of land practice to marine use, but they all serve to show the constant progress which has taken place.

THE PADDLE WHEEL.

The first marine engineering in the modern sense was the adaptation of the steam engine as already in familiar use on shore to a modification of the centuries-old method of mercantile propulsion, the oar. I believe some attempts were actually made to adapt the steam engine to a series of oars, which would have meant something like a mechanical trireme; but of course the trained mechanical sense soon saw that the collection of the oars in a revolving wheel was the correct solution. As oars had been used on both sides, so it was natural at first that the paddle wheels should be on both sides; a center wheel was also tried, but it is interesting to remark that practically about the same time that the sidewheels were used on the seaboard, the sternwheel was introduced on the western rivers. The first marine engine was the shore engine, modified to suit the circumstances; and thus on the seaboard the engine was designed and worked with what we now consider an exceedingly low pressure. On the western rivers, where the change had been made in the location of the wheel, there was also the additional change of dispensing with the condenser and using very much higher pressures. It was doubtless due to this fact—that the first non-condensing engines really carried a very high pressure—that the term "high-pressure" in the early days meant non-condensing. The reason for the difference is of course very clear; the western rivers are very shallow and it was necessary to make the machinery as light as possible; on the seaboard and the rivers of that section there was deep water, and the vessels had displacement enough to permit of heavy machinery.

Ordinarily the history of this olden time could have only an antiquarian interest for us, but we are unusually fortunate in still having with us in the active practice of his profession an engineer who saw the first commercially successfully steamboat, the *Clermont,* so that through our "grand old man of engineering" Mr. Charles H. Haswell, we still have a living connection with that earlier time. One of my former assistants some years ago contributed a series of articles to one of the engineering magazines and has given some data as to the performance of the *Fulton,* the first American steam man-of-war, whose machinery was designed by Mr. Haswell, who was also her first chief engineer. An extract from the *Fulton's* steam log for January, 1838, shows that the maximum steam pressure was eleven pounds, the vacuum twenty-four inches, and the maximum revolutions per minute eighteen.

THE SCREW PROPELLER.

As time passed on and experience was gained, there was naturally an improvement in workmanship and design and a moderate increase in steam pressure, but about 1836 the screw propeller was brought forward for driving large vessels. This was not the first application of the screw propeller, which had been used successfully on a small steamer or launch about 68 feet long as early as 1804 by Col. John Stevens, the grandfather of Col. Edwin A. Stevens, who is now so active in marine work, and the father of

*Address delivered before the American Society of Mechanical Engineers, January 31, 1905.

Robert L. Stevens, who was the most famous of the name for his work in connection with marine engineering. It is to be noted that this date is prior to that of the building of the *Fulton*, but naturally, in the first steam war vessel, it was not considered desirable to do anything of an experimental nature, a condition which has obtained to some extent ever since, and probably always will. It was about ten years later that the propeller began to come into general use, and entirely displaced the paddle wheel for ocean-going steamers. The reason for this change is easy to see on a little consideration. On a long ocean voyage the change in displacement is due almost entirely to the consumption of fuel. In the case of the propeller this makes practically no difference in its immersion or in its efficiency, while in the case of the paddle wheel the immersion of the floats would be changed, with a diminution of efficiency. Further than this, the paddle boxes offered very great resistance to strong head winds and also brought severe stresses on the ship, due to rolling in heavy seas; the propeller not being affected by either of these last two causes. To-day for work in deep water, the screw, of course, is the only propeller; but for river work, particularly in shallow rivers, the paddle wheel is still used. Efforts have been made, and some of them exceedingly ingenious, to adapt the propeller to use in shallow water, and a certain amount of success has attended the efforts of such brilliant engineers as Yarrow and Thornycroft, not to mention our own Mr. Charles Ward, who has done some work in this connection. The fact remains, however, that damage by sand bars, snags, etc., may easily render screw machinery inoperative, while, as expressed by an engineer who had designed many western river boats, "any wood butcher can repair a stern wheel."

Probably fully as much has been done to improve the design of propellers, as time has gone on, as any other part of marine machinery. In the early days the rules for propeller design were exceedingly crude, but with the slow engine-speeds which then obtained the effects were not so noticeable. As engine-speeds increased, however, it was seen that these old rules were utterly inadmissible. There is no good excuse, however, for progress having been so long delayed; for the designs still remained too crude even after Isherwood's famous Mare Island experiments in 1868. Probably one of the great troubles with screw-propeller design at the beginning was the mistake made in considering the action of the screw as analogous to that of a bolt working in a nut, from which it was inferred that the smaller the slip the greater the efficiency. As a matter of fact, a screw propeller is really a pump for driving a mass of water astern, the reaction from which drives the vessel ahead. When this had once been realized, it was seen that there must be a certain amount of slip, and that under proper conditions there could be relatively large slip and still high efficiency.

Multiple screws were used as early as our Civil War on some vessels known as "tin-clads" on the Mississippi, their adoption being necessitated by the shallow draught. Twin screws were first used in war vessels, where the necessity for keeping the machinery below the deck would not allow of all the power being conveniently used on a single shaft, but the great advantage they possess of security against total disablement and for maneuvering soon made them the rule for all naval vessels large enough to admit of them. They were much longer in coming into the merchant service, where the limitations on naval machinery do not obtain; but since the era of the very large transatlantic steamers —beginning with the *Paris* and *New York* and the *Teutonic* and *Majestic*—all very large vessels have been built with twin screws.

In the navies of France and Germany, the triple screws have been used to a considerable extent, and I used them myself in our own fast cruisers *Columbia* and *Minneapolis*. My own belief is that they have decided merit for vessels using above 10,000 horsepower. This view, however, was not shared by my board colleagues in the navy department, so that their marked success in the two vessels named was not allowed to be repeated in later designs.

With the advent of the steam turbine as a prime mover in ships multiple screws have again come to the front, this time on account of the extremely high speed of rotation of the shafts. The *Turbinia*, the first vessel of this kind, had three shafts with three propellers on each; and the destroyers *Viper* and *Cobra* had four shafts with two propellers on each. The merchant vessels, beginning with the *King Edward*, have been fitted with three shafts.

Before leaving the propeller, I may mention, in connection with the improvements in its design, the care that is now taken to avoid needless friction, by making the hub spherical with a conical tail piece, and by putting covering plates over the bolts securing the blades to the hub so as to continue the outline of the sphere or conoid.

THE SURFACE CONDENSER.

Up to about 1860 the jet condenser was the one usually employed on board ship, which meant, of course, that the boilers were constantly fed with salt water; and this, in turn, meant the deposition of great quantities of sulphate of lime scale on the heating surface. With the low pressures then prevalent this did not greatly affect the economy of the boilers, except that, as "blowing off" to keep the density of the water down was a continuous practice, there was a certain loss of heat, and of course there was the necessity for frequent scaling of the heating surfaces. However, they were effectually protected against corrosion. About 1860 the use of surface condensation became general, and as this greatly reduced the amount of scale formed, it was practicable and safe to increase steam pressures, which accordingly resulted with a consequent reduction in the weight of machinery per unit of power.

An accompaniment of the introduction of surface condensation, which was at first supposed to be a result of it but which as a matter of fact was not, was a tremendous increase in the corrosion of the boilers and shortening of their life. This was especially noticeable in the tubes which, as the thinnest part of the boilers, gave out first. All sorts of theories were advanced to account for it, some of which we can now see to have been utterly ridiculous. Probably one of the most fanciful was that which regarded the boiler and condenser as forming a gigantic galvanic battery, the copper condenser tubes forming one pole and the boiler the other. The real facts were developed as a result of the investigation by the Admiralty Committee on boilers in the '70's, which showed that boiler corrosion was simply rusting, and had been due to gross but unintentional neglect. It had been a very common practice, particularly in naval boilers, when they were not in use, to blow out the water, and take off the manhole plates "to let them air." It was this "airing" which caused the corrosion. Now, when boilers are laid up, they are filled with water which is made slightly alkaline, and this effectually prevents corrosion.

THE CYLINDRICAL BOILER.

The early boilers in sea-going vessels were of what has been called the "box" type; that is, the boiler was a cubical box with a thin shell, the real strength being given by braces running in three directions. When surface condensation had made higher pressures possible, it was soon found that the multiplicity of braces, as pressures were increased, made an impossible condition of affairs, and this led to the design of the cylindrical boiler, whose shell was self-bracing, and left the only braces, those needed for the heads and flat surfaces. This boiler so thoroughly met the conditions arising that it has remained the favorite even up to the present day. At one time an effort was made to save room by making the boiler elliptical, but this was soon found to be unsatisfactory and impracticable, and was abandoned after only a few examples.

The earliest cylindrical boilers were single-ended, with two furnaces, but with the advent of reliable mild steel the diameters were increased and the boiler was made double-ended, with upper ends rounded to save bracing; so that the largest cylindrical boilers to-day have as many as eight furnaces, four in each end in pairs; that is, the two furnaces at each end and on the same side of a vertical diameter have a common combustion chamber. The saving in weight due to the double-ended boiler is evident at once, and also the reduction in the feeding apparatus required.

Notwithstanding the advent of the water-tube boiler, which will be mentioned further on, and its practical preemption of naval practice, the cylindrical boiler still remains the favorite for the merchant service and has been used for pressures as high as 220 pounds, even in the largest sizes, on such vessels as the *Kaiser Wilhelm II.* The highest recorded pressure is 255 pounds, on the *Inchdune*.

THE COMPOUND ENGINE.

From a very early period steam had been used expansively in marine engines, and indeed sometimes to a ridiculous extent. Some engineers as late as the Civil War hardly seemed to realize that there was any limit to expansion, although Isherwood's famous experiments on the *Michigan* in 1861 had demonstrated conclusively that, with low pressures, only a very moderate expansion is permissible, beyond which any further expansion is attended by an economic loss. As pressures increased it was natural and correct that a higher range of expansion should be used, and this made practicable the compound engine, where the expansion occurs in two stages, the high-pressure steam from the boiler being limited to a small cylinder from which, in turn, the steam of lower pressure is exhausted to a larger cylinder. As you all know, the compound engine was invented almost as early as Watt's separate condenser, Hornblower's patent dating back to 1771, and Wolff's patent for a two-cylinder engine dating back to 1804. With the low pressures prevalent at that time the compound engine was actually at a disadvantage compared with the simple one. When pressures had reached about 60 pounds, however, the compound engine began to assert itself, the pioneer in that respect being John Elder, of the firm of Randolph & Elder, which is now known as the Fairfield Engine Works. It is interesting to note that the Allan Line of steamers, which is now the pioneer in introducing the steam turbine for an ocean-going steamer, made the last scientific stand against the compound engine, going so far as to take duplicate vessels, and engine one with compound and the other with simple engines of the same power. The actual experience with these two vessels, where the simple engine with the high ratio of expansion was constantly in trouble from breaking down, was a convincing proof that high ratios of expansion in a single cylinder were impracticable.

With the improved workmanship which had come by this time, and with the improvement in materials, to which we shall refer in a moment, which came later, the compound engine advanced to a high state of perfection, and for large powers the three-cylinder type, with one high-pressure and two low-pressure cylinders, became a favorite for all large vessels. These engines were probably as fine specimens of marine engine designing as have ever been seen, and included some exceedingly ingenious valve gears designed to secure variable expansion and an equalization of work among the various cylinders. As we shall see later, the further advance relegated these beautiful mechanisms to the engineering museum.

THE ADVENT OF MILD STEEL.

It is probably difficult for the young men in our technical schools of to-day, who are familiar almost entirely with mild steel and very little with wrought iron, to realize what a change came in engineering when the production of mild steel became a commercially reliable matter. When we look back at the way in which some of the vital elements of a big marine engine were made, we are almost inclined to wonder that the material was reliable at all. The difference between a large wrought iron shaft such as old Hughey Dougherty used to make at the Morgan Iron Works, and one of the mild steel shafts made at Bethlehem, is as great as could be imagined. Nearly the same is true of boiler plates. The young engineer of to-day would hardly know what was meant by a lamination or a "cold shut." The very method of manufacture made it necessary to use a large factor of safety in designing, with the result that the working stresses permissible were very low and the weight of machinery inordinately high. With the advent of mild steel and the introduction of careful and systematic testing, the designer had a material on which he could place absolute reliance, so that the factor of safety could be greatly reduced. As a matter of fact the factor of safety has been reduced from 8 or 10 to 5, and sometimes as low as 4.5.

In looking back over my own experience, I do not see how we could possibly have built engines of the size and power now common with wrought iron for pistons and connecting rods and shafting, and it is, of course, absolutely certain that we could not have built the cylindrical boilers of to-day. The change began in the later '70's and had become almost complete by the middle of the '80's.

We must not fail to notice in the change to steel the use of steel castings, which have displaced cast iron in many places, with attendant great reduction in weight. The first use of steel castings was attended with considerable annoyance because it was unfortunately assumed, perhaps naturally, that, barring the much greater shrinkage, it could be treated very much the same as cast iron, and it was consequently asserted with confidence that anything which had been made in cast iron could be made in cast steel. This is doubtless true to-day, but it certainly was not true ten or fifteen years ago, as I know to my personal sorrow, because designs which would have been considered simple in cast iron had to be entirely changed to meet the conditions then existing for steel castings.

It may be well to mention in this connection that about the same time that steel came into use displacing wrought iron, white metal for bearings and the stronger bronzes also came into use, thus giving the designer much better materials to work with and again reducing weights. We may also mention here the gradual displacement of copper for steam piping by steel pipes, owing to the fact that for the high pressures common at present copper pipes would have to be very thick, making it difficult to secure a sound joint, and also to the serious diminution of the strength of copper by the high temperature.

FORCED DRAFT.

Forced draft dates back of course to Stevenson's *Rocket*, and its first use for marine purposes was by Mr. Robert L. Stevens on the Hudson River steamers in our own country prior to the Civil War. During that war Mr. Isherwood built a number of gunboats which used forced draft, but it had fallen into disuse until about 1882 for naval vessels, when it was introduced into the English navy and still later was applied in the merchant service.

In naval machinery forced draft has been of the greatest possible importance, because it has reduced boiler weights probably almost one-half. In the navy the natural limitations as to space and weight prevent the use of forced draft with very much economy of fuel. It is obvious that if the rate of combustion is increased from 15 pounds of coal per square foot of grate to 40 pounds, there ought to be an attendant increase of heating surface. In the merchant service, or at least in certain classes of vessels in that service, it is possible to do this, and in one of my annual reports I made a comparison between the boilers of a merchant vessel called the *Iona* and those of the *Baltimore*. In the *Iona* there were 75 feet of heating surface for 1 of grate, while in the *Baltimore* the ratio was about 30 to 1; but had the *Baltimore's* boilers been designed with any such ratio as in the *Iona*, their weight would have been almost double the weight of all the machinery of that vessel as actually built.

Mr. James Howden has made a specialty of forced draft under economical conditions, heating the air before admission to the ash-pit; and his system is now in use on most of the large steamers, the aggregate horsepower running up, I believe, to over a million.

HIGH ENGINE-SPEEDS.

About the same time as the reintroduction of forced draft in naval vessels, the improved materials and workmanship made it possible to get higher rotational speeds, and, as remarked earlier, the true conditions of propeller design being understood, there was a marked increase in the speed of rotation of the engines. Naval vessels, from the necessary limitation of keeping the vital parts of the machinery protected as far as possible, have always run faster than the engines of the merchant service, although this did not always mean that their piston speed was greater. The mistake is sometimes made of attributing lighter machinery to higher piston speeds, but unless this is accomplished by increasing the number of revolutions it will not produce that effect. In the early days, 60 or 70 revolutions per minute for what was then considered a large engine of 4,000 or 5,000 horsepower, was about the limit, but in engines of as much as 8,000 horsepower for a single set one finds the revolutions to-day as high as 130. Of course it is not practicable to show to just what extent any one line of progress has reduced weights, by comparing the machinery at periods wide apart, because the increase of steam pressure, increased rotational speeds, improved materials and better designing have all gone along together;—but it is interesting to note that in the *Warrior* of 1861, with 22 pounds boiler pressure and 54 revolutions, the horsepower per ton of machinery was 6, while in the *Minneapolis* of 1891, with 165 pounds pressure and 133 revolutions, the horsepower per ton is 10.9. From a simple mechanical standpoint, contributing agencies to the high speeds are the much more perfect journals of the steel shafts, and the superior white metals used for bearings, and the rigidity of the steel hull of the ship, as compared with the older conditions. The best makers now grind their bearings true to a mandrel which represents perfect alignment. In the old days all main shaft bearings were hollow for water circulation, which was generally needed, and there was usually provision for a spray of water on the crank pins. In the modern engines which have been well built and are carefully adjusted, there is no necessity for water even at very high speeds under full power.

THE MULTIPLE EXPANSION ENGINE.

The change from the simple to the compound engine involved a certain amount of difficulty and opposition, but the lesson was then learned pretty thoroughly that the amount of expansion in a single cylinder was moderate. Consequently as steam pressures rose the leaders of the profession became convinced that to secure adequate economy a further stage of expansion was necessary, and this brought about the triple expansion engine, the credit for which is deservedly given to Dr. A. C. Kirk, of the firm of R. Napier & Sons, of Glasgow, who first successfully used the triple-expansion engine on the steamer *Aberdeen*. The adoption of the triple-expansion engine was almost immediate, and, after the success of the *Aberdeen* was demonstrated, all new engines of any size were built on that principle. It seemed a logical extension of this idea that with still further increase of pressure there should be the quadruple-expansion engine, and a number of these have been built; but the advantage as compared with the triple-expansion engine up to the point beyond which pressures have thus far not gone, does not seem to be clearly demonstrated, and a great many designers are adhering to the triple-expansion engine with four cylinders, one high, one intermediate, and two low-pressures.

WATER-TUBE BOILERS.

Like so many other details not only in marine engineering but in other lines of work, features which are introduced in a practical way in recent times are found to have a comparatively ancient origin. This is true of the water-tube boiler, which in its recent use dates from about 1880. The excavations at Pompeii have shown small boilers almost identical in construction with some of the best of our water-tube boilers, although they were doubtless used only for a circulation of hot water.

The object of the water-tube boiler is to reduce weights, give greater safety against explosion, greater rapidity of raising steam, and an increase of economy in the generation of steam. The various makes of water-tube boilers are too numerous to mention, but they divide themselves into two broad general classes; those with straight tubes of large diameter, say four inches; and those with curved tubes of small diameter, from an inch to an inch and a half. Probably no single boiler possesses all the merits which a perfect water-tube boiler should have, and in nearly every case the attempt to secure certain advantages brings attendant disadvantages, and *vice versa*. The large straight tube boilers are not so light as the ones with small tubes; and it is more difficult to secure adequate economy, which is dependent largely upon skillful baffling. They do not permit of such rapid raising of steam from cold water as the smaller tube boilers, because, like the Scotch boiler, they carry a large reserve supply of water in the boiler after the manner of the Babcock and Wilcox boiler. On the other hand, they permit the replacement of a defective tube and of the cleaning of a tube much more readily than the tubes which are bent. Likewise it is only necessary to carry one size of spare tubes, while the bent tube boilers require several sizes and shapes.

As far as safety against explosion is concerned, there can be no doubt that there is less danger of an actual disaster affecting the whole ship,—although the worst accident which we ever had with a boiler in my naval experience was in connection with a water-tube boiler on a torpedo-boat, where all the crew of a fire room were scalded to death. Nevertheless, the boiler itself did not explode and was quite easily repaired. On the other hand, a few years before this a locomotive boiler on a torpedo-boat in Germany exploded through the collapse of the crown sheet due to low water, and not only killed all the people in the fire room, but tore up the decks and utterly ruined the boiler itself. In this connection it is a cause of sincere congratulation that since the explosion of the *Thunderer's* boilers in the English navy many years ago, there is, I believe, no record of the explosion of a large, well built, marine boiler. For naval purposes, where weight is such a great consideration, the water-tube boiler commended itself at once, and it has now become the established practice in all navies to use only water-tube boilers in new ships. Our English friends had some trouble with the Belleville boiler, but this seems to have been due to some extent to lack of familiarity with it, and other legitimate reasons. In the merchant service, where weight is not so precious, the water-tube boiler has not thus far so thoroughly commended itself to designers; and, as remarked earlier, all of the latest large vessels are still using cylindrical boilers. Some of the reasons for the hesitation to adopt water-tube boilers are that, of necessity, an installation of large power means a very large number of boilers, because the water-tube boiler does not admit of single units of great power comparable with the large double-ended cylindrical boilers. This means an immensely greater complication in the way of piping, valves, fittings, feed pumps, etc. Moreover, owing to the small amount of contained water, which is very desirable in so far as weight is concerned, the water-tube boiler is very sensitive as regards steam pressure and water level, requiring very much more care and attention than the cylindrical with its immense amount of contained water. It seems to me not impracticable that the able men who are engaged in the study of this question will finally succeed in developing a type of water-tube boiler which will commend itself for use in the merchant service as well as in the navy. Some of the boilers fitted in the United States naval ships had but six minutes of water endurance after the pumps stopped working, while one of the Babcock and Wilcox boilers adapted to our naval use has as much as twenty-five minutes endurance, which is a close approximation to the Scotch boiler.

AUXILIARIES.

In the early steamers, almost the only independent steam auxiliary was a single pump, which could be used for feeding the boilers while under banked fires or with the engine stopped, and for pumping the bilge. The other pumps were attached to the main engine. Such things as steam capstans and winches, steam steering gear, distilling apparatus, evaporators, forced-draft blowers and electric light engines, were not dreamed of. As time went on and the size of vessels increased, steam capstans and winches and steam steering engines came in. Then it began to be found desirable, particularly for naval engines, to remove all the pumps from the main engine, leaving it nothing to do but turn the propeller, and this brought about independent air and circulating pumps and feed pumps. Further progress introduced the distiller and evaporator, the forced-draft blowers, and the electric light engine.

Most of these auxiliaries, from the nature of the case, are driven by simple engines, the pumps usually being for very slow piston speed and without expansion. The result is that the economy of these auxiliaries is naturally very low, and for some years past it has been the aim of designers to do something to either make the auxiliaries themselves more economical, or at least to utilize the heat in the exhaust steam. In some cases it has been arranged to have the auxiliaries in the engine room take their steam from the first receiver and exhaust into the second, thus, in effect, making all their cylinders part of the intermediate cylinder, as far as the steam cycle is concerned, with its attendant economy. I remember one of my former associates telling of how he had actually tried this on his ship with a saving of some six tons of coal a day, for machinery which was then working at about 8,000 horsepower. In the case of the feed pumps, arrangements have been made to turn the exhaust steam into the suction pipe, thereby having this heat carried back into the boiler, but this has not been done to any very great extent. Another plan has been to turn the exhaust from all the auxiliaries into a feed water heater through which the main feed to the boilers would go, and this has been attended by very good results.

The question has been raised repeatedly by electrical engineers that it would be a good plan to drive the auxiliaries by electric motors, on account of their very high efficiency even at fractional loads. For the engine-room auxiliaries and the boiler feed pumps it seems to me that this is unreasonable, for it means increased complication and certainly an increase in weight; and it has never been shown to my satisfaction that there would be any material increase in economy, owing to the fact that the dynamos as usually supplied on board ship are not large enough to have very economical engines, and from the fact that there are so many machines each with an efficiency less than unity in the circuit between the boiler and the final pump.

There are some auxiliaries on board ship, however, where it would seem motors could be used to advantage, notably for driving the force-draft blowers. From the necessities of the case these are usually stowed in hot and rather inaccessible places, and it is difficult to keep the engines in good adjustment. It hardly seems to me, however, that direct-current motors are well adapted to this service, as they would have to be of the enclosed or dust-proof type, which reduces their heat carrying capacity, and as they have to go in places where the heat is already very great. If alternating current machinery were installed, it seems to me that the induction motor with its extreme simplicity and ability to withstand very hard usage would be especially adapted to this work.

It is doubtless known to all of you that in modern ships the turret turning is done by electric motors. While this is an engineering matter, on board ship it comes within the purview of the ordnance officer, and therefore I have not dwelt upon it. The anchor capstan and steering engine should be electrically driven, but because of peculiar conditions existing in the navy this has not been done.

THE STEAM TURBINE.

The latest note of progress in marine engineering seems to be the advent of the steam turbine, which for some purposes has passed the experimental stage, and has given great satisfaction. As already mentioned, a number of small vessels of the torpedo-boat class have been built with steam turbines, and this has been followed up by their use in a number of excursion steamers and cross-channel steamers between England and France and England and Ireland. The Allan Line of steamers have also decided to equip two large new steamers with turbines, and, as we all know from the technical press, the Cunard Company have had a very able committee considering the question of their adoption for the two new flyers which that company is to build,—as a result of which they have decided to use turbines in them.

The turbine has had an extended use in the last four or five years on shore for driving electrical generators, and this has been so satisfactory that the pioneer work of the Westinghouse Company in this country has been followed by the General Electric Company, the Allis-Chalmers Company, and a number of other engine builders, who seem to have reached the conclusion that for large powers at least the turbine is quite sure to supersede the reciprocating engine. For constant speed at its rated load the turbine is very economical, comparing in this respect with the most economical reciprocating engines, and its economy does not fall off so rapidly with decrease of load at constant speed as is the case with the reciprocating engine.

For marine purposes two questions have bothered those who were seeking information, one, the question of reversal, and the other, that of economy where not only the power but the speed is reduced, as is of course necessary in the propulsion of vessels. With respect to the former, different methods have been suggested and tried in different cases. In some instances Mr. Parsons has used separate reciprocating engines which are normally idle. In others, and this appears to be in his latest practice, there are reversing turbines inside the exhaust passage of the ahead turbines, so that while the ship is going ahead these turbines revolve idly, after the manner of a fly wheel, in an excellent vacuum. When the ship is to be reversed, steam is admitted direct to these turbines and secures the reversal.

With respect to economy, there is, of course, a marked falling off from that at full power, but not more so than in the case of reciprocating engines. It seems hopeless to expect that any machine will work with the same economy at one-tenth power that it does at full power, and it would be unreasonable to expect the turbine to do this when the reciprocating engine does not.

The advantages of the turbine are, the entire absence of reciprocating parts, of bearings to be adjusted, and the extreme simplicity of operation, together with the great reduction in weight due to the very high speed. Added to this is the entire freedom from danger due to priming of the boilers, the only result being a slowing down of the turbine and reduction of economy. There is also freedom from lubricating oil getting into the boilers.

Propeller design with the turbine is more difficult than with the reciprocating engine, because the conditions are entirely different from those which have hitherto obtained, and there is so little experience with propellers running at speeds of over 1,000 revolutions a minute in the case of small ships, or at 500 to 750 in the case of large ones. The Cunard propellers, it is understood, are to be limited to 180 revolutions per minute. For it must be remarked that in spite of the fact that we now have very clear and logical rules for the design of propellers under existing circumstances logically worked out, nevertheless these rules and formulæ came after the experience rather than before. This matter, however, can undoubtedly be cared for, and when more experience has been gained the design of propellers will be as easy as for existing conditions.

For naval vessels from a military standpoint the turbine has a great deal to commend it, inasmuch as the machinery will stow very well in the ship and be out of harm's way, the propellers are so small and so well immersed that there is no chance for racing even in the heaviest seas, and all questions of vibration are eliminated. As already mentioned, the saving in weight is also a matter of decided value, if it can be done.

CONCLUSION.

We have now considered very hastily the important epochs in the history of marine engineering, and it will be seen that they indicate steady progress along certain lines. There has been a steady increase of steam pressure, increase of rotational speed and diminution of weight, accompanied by increased economy in the making and using of steam. If time had permitted, it would have been very interesting to compare such a vessel as the *Great Eastern*, which for so long a time was the criterion of immense size, with the *Celtic* and *Cedric*, which are even larger than she was. The *Great Eastern* was simply about thirty years ahead of her time. She was a remarkable production and a great credit to her designers in every way, but she was a commercial failure because marine engine manufacture had not yet reached the point where such a huge vessel could be operated profitably. She carried more than twice as much coal as one of these present day vessels, which easily makes the same speed with machinery weighing probably not more than one-third of what hers did.

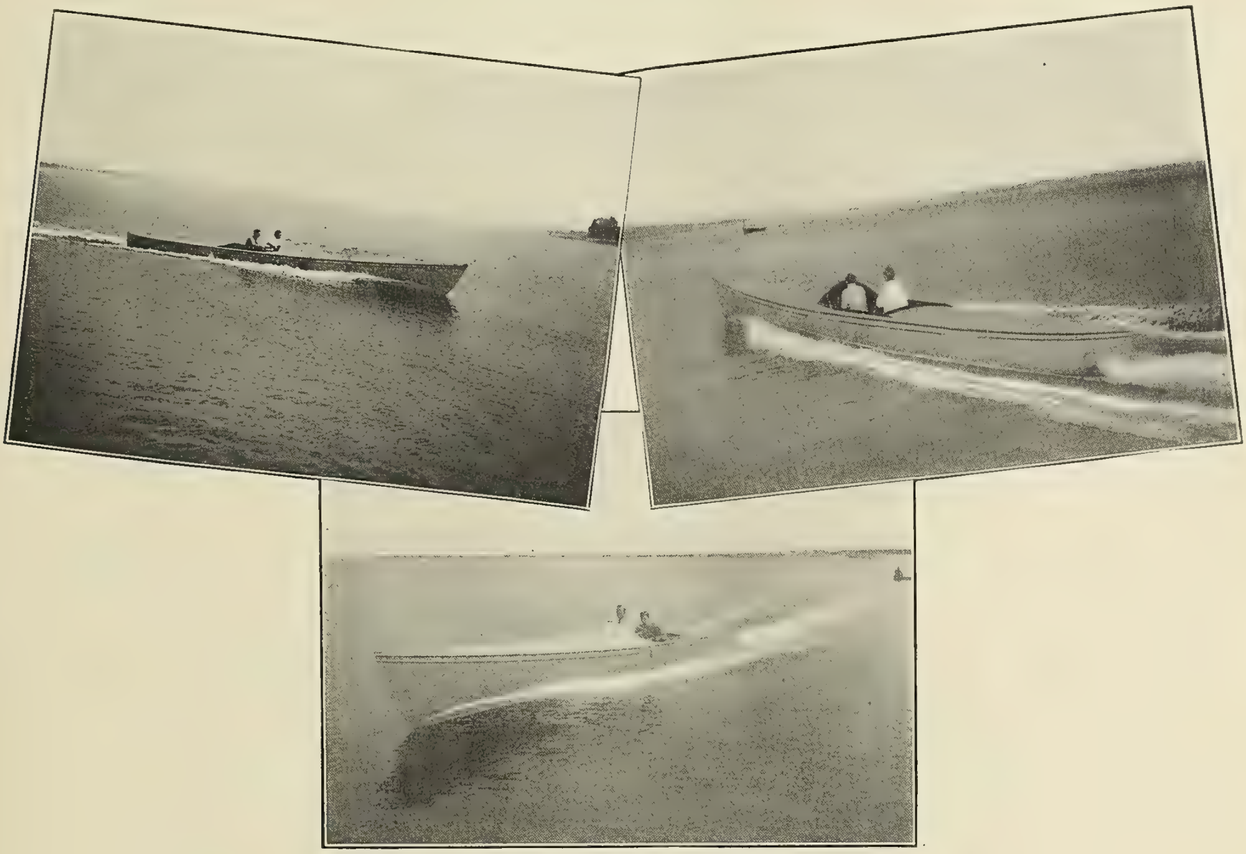
The economy of the marine engine, or of the turbine if it displaces the engine, has reached a point which does not leave much room for improvement in materials and workmanship. Yet it will be unreasonable to believe that we have reached finality, for it is likely that there have been numerous periods in the past when the designers of those days could not see what the next step in advance would be, and so far as their knowledge went their design was nearly perfect. Of course there was certainly plenty of margin for increased economy with them from which we are barred, but I have no doubt that if I could live to be as old as Mr. Haswell I should see some decided improvements in the course of the next thirty years.

A NEW SPEED LAUNCH.

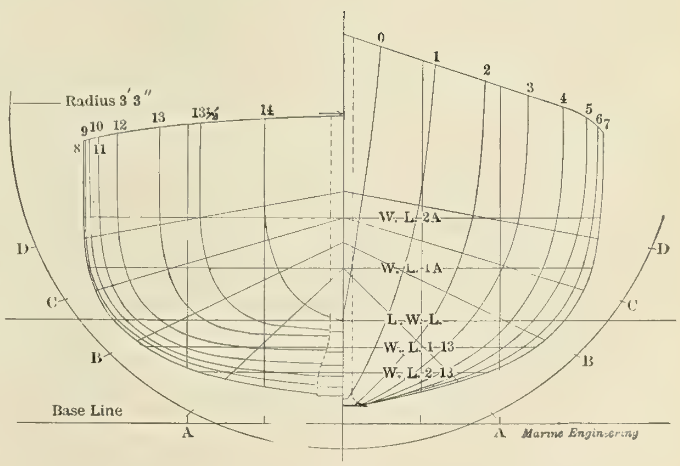
We present photograph and plans of a fast power-boat designed by Mr. Frederick S. Nock, of East Greenwich, R. I., which boat has the following dimensions:

Length over all	37 feet 8 inches
Length water-line	35 feet 0 inches
Beam, extreme	5 feet 0 inches
Beam at water-line	4 feet 4 inches
Draft to rabbet	0 feet 9 1-2 inches
Draft at propeller	2 feet 9 inches
Displacement	3,000 pounds

The hull, of course, is built of wood, the keel being oak, 1 1-4 by 7 inches amidships and tapered at the ends. The stem and stern posts are likewise of oak, 2 1-4 inches deep. The frames measure



THE NEW LAUNCH AT FULL SPEED.



BODY PLAN.

THE LINES OF THE HULL.

3-4 inch square and are also of oak, being spaced 6 inches from center to center. At each alternate frame a floor is fitted. The sister keelsons are of spruce 1 1-2 inches wide, the upper side of the keelson being level with the under side of the cockpit floor. The fore-and-aft bearers of the engine bed are of 2 1-4-inch oak, being morticed over the frames and heavy floors, and securely bolted to the keel. The deck beams are spruce and the planking is white pine, 3-8 inch thick, covered with 6-ounce canvas laid on shellac. The side planking of the boat is of 1-2-inch cedar. The boat is divided into four compartments by means of galvanized steel bulkheads aft of stations 2, 8, and 13.

The shaft bearings are aluminum bronze, bolted through oak blocks fastened between frames inside of the planking. The rudder is comprised of a 3-16-inch sheet of tobin bronze with a forged tobin bronze shank, and is actuated by a quadrant.

The motor is a four-cylinder engine of the four-cycle type, manufactured by the Buffalo Gasoline Motor Company, and actuates a propeller 26 inches in diameter and 42 inches pitch. At a speed of revolution of 750 per minute the boat will make a little more than 20 miles per hour in smooth water. The gasoline supply is contained in two copper tanks situated one forward and one aft, and having each a capacity of 30 gallons. They are so arranged that the motor draws from both of them simultaneously, thus preventing any change in trim from the consumption of gasoline.

The boat has made several trips outside and has proved very seaworthy. She is not, however, a dry boat, especially in rough water with a quartering sea, but this is perhaps too much to expect in a boat of her size and speed.

It is stated that the Spring of 1905 will see the Japanese Government start the construction of two 18,000-ton battleships and two first-class cruisers of 14,000 and 15,000 tons respectively in the domestic yards.

Dealing with a Broken Crosshead Bolt.

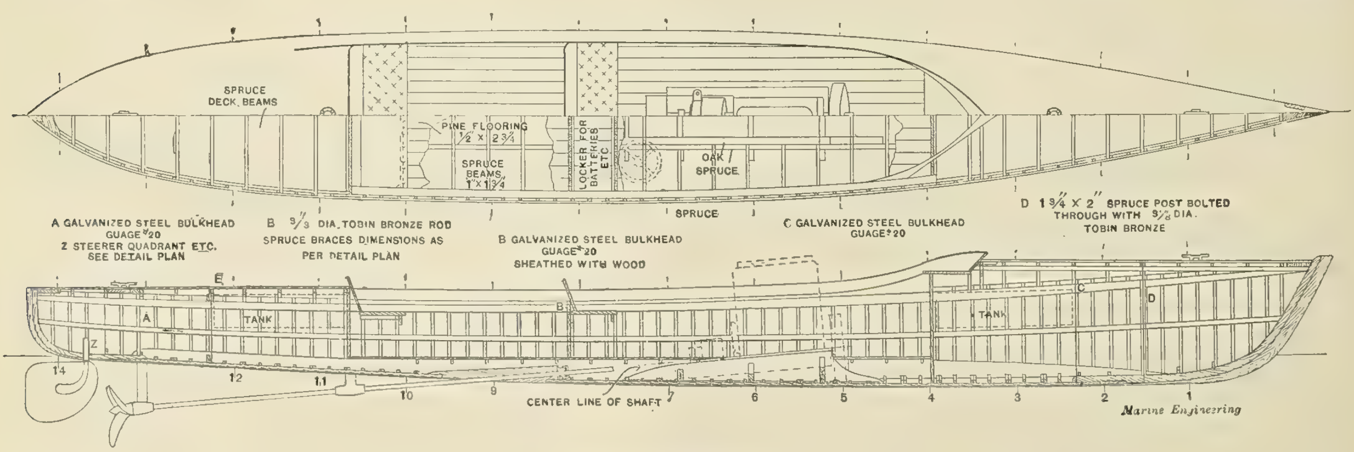
An incident that came under my notice the past summer may be interesting to some of your readers as an example of the quickness with which the marine engineer deals with difficulties which he often encounters.

The S. Y. ——, on a cruise "down east" to the provinces, had run into rather bad weather, and was rolling and tumbling about as only a steam yacht can in a bad sea, when off Cape Sable a snap, followed by a jar and a succession of heavy knocks, came from the low-pressure engine. The first assistant, who was on watch, immediately shut off steam and moved the reversing gear into mid-position. By this time the chief was in the engine room.

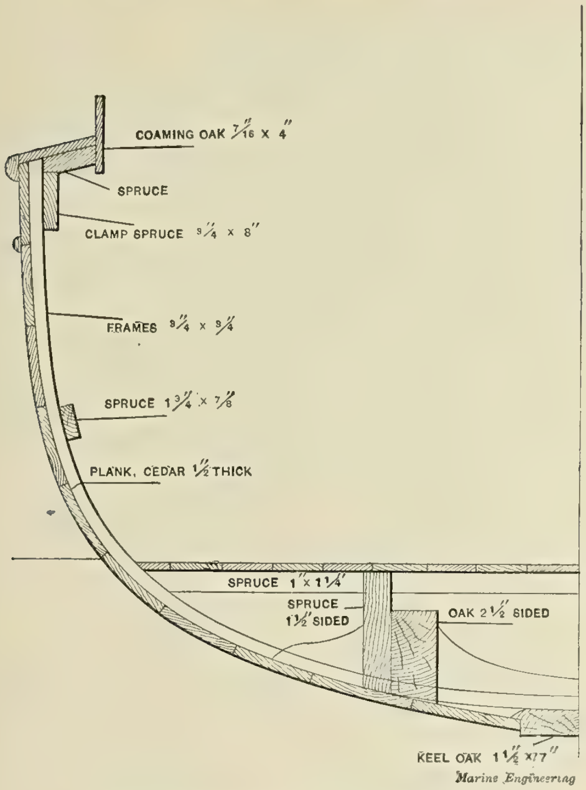
On looking the engine over, a low-pressure crosshead bolt was found snapped off and its mate badly bent, but strangely this was all the damage, everything else being intact, owing to the quickness of the engineer on watch. There were no spare bolts on board, and the yacht was in a bad place, so what was to be done must be done quickly. A part of the crowd under the first assistant removed the low-pressure connecting rod, dropped the piston to the bottom, and shoved the crosshead down from the cylinder bottom.

The chief, with another crowd, was busy at the low-pressure valve gear, and what he was doing struck me as being a bright idea; at any rate, it saved us a lot of time, and enabled us to get under way at least half an hour sooner than we otherwise would. The low-pressure had two piston valves and the chief simply disconnected them and secured them, one up and the other down, so as to make a passage through one into the top of the cylinder, and exhaust through the other into the condenser. The engines were then started with high and intermediate working, and ran in that condition until we reached Halifax. The engines were stopped only 35 minutes, and it would have been much longer had the chief stopped to remove a valve on the piston.

H. H. Austin.



PLAN AND INBOARD PROFILE.



MIDSHIP SECTION OF NEW SPEED LAUNCH.

The New Cunarders.—Many interesting tests have been made in connection with the design of the new Cunarders of 25-knot speed now building. The tests were made with a large model of the vessels, to determine the form of the stern and the size of the four propellers. Previous experiments have shown that the shape given to the after part of a ship to accommodate the stern tube and shafting of the propellers materially influences the efficiency of the screws, and affects the speed for a given power. The immersed surface is increased by the bossing out or by the brackets, and the flow of water to the propellers may be interfered with. With four shafts and screw propellers the problem increases. The model was built to run in a tidal river, and had a stern easily altered to suit various suggested forms. This model was towed without propellers, and with various forms of brackets, and was also driven by propellers. The problems tested had reference to the distance of the outside propellers from the shell of the ship and their position in relation to the inner propellers, which are as close together as the circumstances permit, but the blades of the one propeller will not overlap those of the other. The arrangement arrived at will insure the greatest measure of security as there will be no overhang of shafting outside the hull.

The Coming Motor-Boat Show in Boston.

The boat show to be held in connection with the Boston Automobile Show, March 13 to 18, 1905, promises to be a record-breaker. The whole lower floor of Mechanics' Building, comprising 31,752 square feet of exhibit floor space, has been assigned for the exhibit of boats and boat accessories. Up to this writing the manager reports that 20,000 square feet has been allotted in this department. Many of the most prominent makers in the country have taken space, and applications for information and space are now in hand from eighteen other makers.

Special attention is being paid to this department by the management and there is every indication to believe that it will be the most successful display of boats and accessories ever held, and as the New England states are the most fertile field for this line of business, the claim by the management that profitable results are bound to be obtained seems to be a reasonable one.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, report under date of February 10, 1905, the following percentage of completion of vessels building for the United States Navy:

			Jan. 1.	Feb. 1.
BATTLESHIPS.				
Virginia	19 knots.	Newport News Co.	75.24	76.96
Nebraska	19 "	Moran Brothers Co.	64.91	65.8
Georgia	19 "	Bath Iron Works	71.94	73.61
New Jersey	19 "	Fore River Shipbuilding Co.	74.3	75.7
Rhode Island	19 "	Fore River Shipbuilding Co.	77.1	80.7
Connecticut	18 "	Navy Yard, New York, N. Y.	61.51	64.51
Louisiana	18 "	Newport News Co.	66.5	67.8
Vermont	18 "	Fore River Shipbuilding Co.	31.5	35.4
Kansas	18 "	New York Shipbuilding Co.	40.1	41.3
Minnesota	18 "	Newport News Co.	52.84	55.7
Mississippi	17 "	Wm. Cramp and Sons	17.84	20.6
Idaho	17 "	Wm. Cramp and Sons	15.39	18.09
New Hampshire	18 "	New York Shipbuilding Co.	0.0	0.0
ARMORED CRUISERS.				
Pennsylvania	22 knots.	William Cramp and Sons	98.25	98.25
West Virginia	22 "	Newport News Co.	98.5	99.25
California	22 "	Union Iron Works	68.7	70.
Colorado	22 "	William Cramp and Sons	99.27	100.
Maryland	22 "	Newport News Co	95.14	96.5
South Dakota	22 "	Union Iron Works	65.9	67.9
Tennessee	22 "	William Cramp and Sons	60.53	63.13
Washington	22 "	New York Shipbuilding Co.	60.7	62.7
North Carolina	22 "	Newport News Co	0.0	0.0
Montana	22 "	Newport News Co	0.0	0.0
SEMI-ARMORED CRUISERS.				
St. Louis	22 knots.	Neafie and Levy Co.	58.5	58.5
Milwaukee	22 "	Union Iron Works	65.1	66.7
Charleston	22 "	Newport News Co.	88.32	90.22
PROTECTED CRUISERS.				
Chattanooga	16½ kts.	Lewis Nixon	99.13	99.13
Galveston	16½ "	Wm. R. Trigg Co.	96.	96.
GUNBOATS.				
Dubuque	12 knots.	Gas Engine and Power Co.	77.6	85.7
Paducah	12 "	Gas Engine and Power Co.	73.1	76.2
TRAINING SHIPS.				
Cumberland	Sails	Navy Yard, Boston	88.	91.
Intrepid	"	Navy Yard, Mare Island	72.	78.
TRAINING BRIG.				
Boxer	Sails	Navy Yard, Portsmouth	96.	97.
TORPEDO BOATS.				
Stringham	30 knots.	Harlan and Hollingsworth	99.	99.
Goldsborough	30 "	Wolff and Zwicker	99.	99.
Nicholson	26 "	Lewis Nixon	99.	99.
O'Brien	26 "	Lewis Nixon	99.	99.

Coming Ocean Monsters.—It has been commented on as a novelty by some of the papers that the two 35,000-ton "intermediate" 17-knot steamers that are being built for the Hamburg-American line are to have passenger hoists, as well as companionways, leading from the lower decks to the promenades. But a lift, or elevator, was fitted on one of the Atlantic liners built on the Clyde some sixteen years ago. It was ultimately discarded because the rolling of the ship caused the hoist occasionally to jam, and when the ship righted the accumulation of power resulted in a suddenly accelerated speed. There has, however, been immense improvement in lifting mechanism since then, and there may not now be trouble with a modern equipment. In King Edward's yacht there is a hoist for His Majesty's use, but it is of limited capacity. There are ammunition hoists in warships which work well. Whether a large lift, with a 40- to 50-foot travel, will work smoothly under all weather conditions remains to be seen. The *America* is being built at Harland and Wolff's at Belfast, and the *Kaiserin Augusta Victoria* at Stettin. They will carry 3,589 passengers each, 600 first-class, 300 second, 250 third, and 2,139 in the steerage. They will have three promenades, one reserved for lounge chairs. There will be no upper berths in the first-class state rooms. There is to be an *à la carte* restaurant, separate from the dining saloon, where passengers may have what they pay for, distinct from the service included in the fare, and there will be Turkish baths. The *America* will not be ready until the autumn of 1905, and the other steamer in the summer of 1906.

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Naval Appropriations.

As we go to press, word comes from Washington that the bill providing for the increase of the United States Navy, which has already been severely cut in committee, bids fair to lose one-half of its remaining strength, if not to disappear completely. The full needs of the service, as recommended by the general board of the navy, of which Admiral Dewey is the president, comprise: three battleships, five scout cruisers, six torpedo boats, six torpedo boat destroyers, two squadron colliers, and three gunboats. Realizing, however, the fact that the government was facing a heavy deficit, the general board expressed its willingness to compromise on the three battleships and six torpedo boats, allowing the scout cruisers, torpedo boat destroyers, colliers and gunboats to be eliminated from the program. But the house committee on naval affairs was not content with this reduction, and the estimate was cut down to two battleships only, and so reported to the house. Now there appears to be grave danger that even this very moderate provision will be reduced to a single battleship; while the senate seems disposed to go further, and, perhaps, prohibit all increase of the navy during the present session of Congress.

With the foreign policy of the administration demanding adequate naval backing; with the continued vigorous support of the Monroe doctrine requiring the maintenance of such a force as will give pause to any ambitious European power hankering after South American colonization; with the naval experts who had the task of deciding upon the proper augmentation of the navy agreed upon a definite program as necessary for the case in hand—a program not at all excessive, even in its original entirety; we are provided with the not unusual spectacle of a non-technical body, calling in the advice of technical experts, and then deliberately declining to follow the advice so obtained. Unfortunately there can be no appeal from the decision, once made. The result means the loss of exactly one year in the task of providing the United States with the force necessary to preserve its position among the nations, a force all the more necessary because of the peculiar position in which we are placed by the problem of looking after the destinies of the entire western hemisphere. That this problem is self-imposed makes no difference; it has been considered requisite for the preservation of our integrity and our isolation, and has not been successfully assailed. The position is one from which we are extremely unlikely to retreat, nor is there strong reason why we should do so. We are virtually pledged to maintain the *status quo* in the two Americas (and islands appertaining thereto), and we will maintain it.

The reasons actuating the opponents of the desired increase seem to be more of a financial nature than a political. The policy of economy is advocated—a policy of extreme sanity, but, in such a case as this, of doubtful utility. And while the question of economy of expenditure is an exceedingly apt one when the disbursements of the government are greater than the income, yet this condition of affairs is but temporary; moreover, the current cash balance in the treasury, aside from the $150,000,000 gold reserve, is nearly $200,000,000, against which to charge the difference of (say) $10,000,000 between the two estimates.

The situation can scarcely be considered as acute; yet it might well give rise to conditions of considerable awkwardness, if not actual humiliation. With an adequate naval force to back up our demands that the intolerable state of affairs in Cuba in 1897 should cease, we would never have had a war with Spain. It was only our apparent unpreparedness for a conflict which precipitated hostilities. That we were enormously successful against a decadent adversary is no argument in favor of a continued state of unreadiness to maintain our position in the diplomatic world. Our next opponent, if we ever have one, will not, perhaps, be so ill-equipped for the combat, and we may then awake to a realization of the folly of neglecting the opportunities which a time of peace affords—opportunities rendered all the more precious by the fact that the construction of ships now requires as many *years* as it did *months* at the time when Washington uttered the wise advice: "In time of peace, prepare for war."

On this page is depicted the work that is being done in the rehabilitation of the American merchant marine. All of the vessels building for over-sea service are fully illustrated and described.

ABSTRACTS FROM RULES AND REGULATIONS OF THE AMERICAN BUREAU OF SHIPPING.

EDITION OF 1904.

ARRANGED BY HARRISON S. TAFT.

1. Measurements.

ITEMS.		One- Two- Three-Deck Vessels.	Hurricane-Deck Vessels.	Poop; Bridge House; Topgallant Forecastle Deck Vessels.	Raised Quarter and Fore Deck Vessels.
Length.—From fore side of stem to aft side of rudder post: but to aft side of propeller boss in single-screw ships.	L	On L. W. L.	On L. W. L.	On L. W. L.	On L. W. L.
Depth.—From top of bar keel or flat plate keel at center line amidships.	D	To upper deck.	To deck next below the hurricane deck.	To upper deck.	To upper deck.
Girth	G	a. " " "	" " "	" " "	" " "
Breadth	B	Maximum beam.	Maximum beam.	Maximum beam.	Maximum beam.
First Number.—Frames, floors, and reverse frames	F	$\frac{1}{2}$ B + D + $\frac{1}{2}$ G	$\frac{1}{2}$ B + D + $\frac{1}{2}$ G	$\frac{1}{2}$ B + D + $\frac{1}{2}$ G	d. $\frac{1}{2}$ B + D + $\frac{1}{2}$ G
Second Number.—All other members except deck beams	S	F × L	F × L	F × L	F × L
Equipment Number.—Anchors, chains, warps	E	S	b. F × L	c. S	S

a. To second deck in three-deck vessels.

b. Depth measured to the hurricane deck: girth to the second deck, in determining the equipment number for general ocean-going hurricane-deck vessels.

c. To be increased by 10% of itself when combined length of said structures exceeds $\frac{1}{2}$ the vessel's length.

d. $\frac{1}{2}$ B + D + $\frac{1}{2}$ G + Ht. of R. Q. D. above main deck when combined length of said structures exceeds $\frac{2}{3}$ the vessel's length.

In vessels of 700 feet or over in length, the depth and girth are to be measured to one deck higher than for a three-deck vessel.

Scantling of deck and hold beams is to be regulated by the length of their respective longest beam.

2. Scarphs.

Scarphs of bar keels, stems and stern frames should be in length not less than ten times the required thickness of a bar keel.

3. Stems.

Stems are to be of the same scantling as bar keels and they should *maintain their full sectional area* up to the deep load water line with a reduction to 3-4 of said area at their head. They should be rabbetted for the shell plate ends.

4. Stern Frames.

1. The lower part of stern frames forming part of the keel should extend at least 2 1-2 frame spaces forward of the propeller post in single-screw vessels but 1 1-2 frame spaces in all other kind of ships.

2. The propeller boss on each side of the hole for the stern tube should be at least 1 1-2 times the required thickness of a bar keel.

3. Rudder posts should extend to, and be securely fastened to a main-deck beam.

4. High-speed single-screw vessels are to have their propeller and rudder posts of 10 to 20 per cent. greater sectional area than otherwise.

5. Gudgeons on stern posts and rudders should be spaced not more than 5 feet apart.

5. Keels and Center Line Keelsons.

1. Center Line Continuous Plate Keel and Keelson.

a. Said keel and keelson must be equal in depth to the depth of midship floor plates at the center line plus the depth of the tabulated bar keel, with side plates below the floors equal in depth to said bar keel; the combined thickness of the center and side plates being at least equal to the width of said bar keel.

b. (1). If the continuous plate keel and keelson is worked flush with top of floors, a horizontal plate stringer, in width 1 1-3 times the depth of midship floors, must be worked on top of floors at the center line; said stringer plate being clipped to floors and to top of the vertical plate keel and keelson with angle clips equal to reverse bars. If the depth of the center floors is 24 inches or over a continuous vertical plate keelson, in depth 3-4 of a specified depth, with double top angles and a rider plate, must be secured to the top of said horizontal plate stringer at center line by continuous double fore-and-aft angles, riveted back to back and embracing said vertical plate keelson.

(2). If the vertical plate keel and keelson extends above top of floors a horizontal plate stringer is to be worked on each side of said keelson. Width of each stringer plate should equal 3-4 the center depth of midship floors, and they should be secured to said keelson with continuous angles riveted back to back on top of said horizontal stringers, and embracing the top edge of the plate keel and keelson. If the depth of floors amidships is 24 inches or over, the center line keelson is to extend above top of floors at least 3-4 of a specified height; and in addition to the two above horizontal plate stringers and their continuous fore-and-aft angles, two top angles with a rider plate are to be worked at upper edge of said keelson. The vertical plate keelson may be built of two pieces, having their lap between the continuous angles on top of the horizontal plate stringers.

2. Intercostal Center Line Vertical Keelson.

a. Said intercostal keelson should extend above top of floors, so as to be embraced by two continuous fore-and-aft angles riveted back to back on top of floors. If the center depth of midship floors exceeds 12 but is under 18 inches, a bulb plate equal in depth to the main-deck beams is to be riveted to the top edge of the intercostal plate keelson; being embraced by the two continuous fore-and-aft angles on top of floors. If said depth is or over 18 inches a vertical plate keelson, in depth at least 3-4 of a specified height with top angles and a rider plate, is to be worked in lieu of the above bulb plate. When said depth of floors is 24 inches or over horizontal plate stringers, each in width 1-2 the center depth of floors, are to be worked on top of floors on each side of the vertical intercostal keelson and be secured to the top of same by the continuous fore-and-aft angles on top of floors.

b. A middle line intercostal plate keelson may be worked flush with top of floors provided a horizontal plate stringer, in width 3-4 the center depth of midship floors, is worked on top of floors at the center line and is secured to the top of said keelson with double clip equal to reverse bars. Continuous fore-and-aft angle bars; said angle bars with a bulb plate; or a plate keelson with top angles and a rider plate must be worked at the center line on top of said horizontal plate stringer; as when the intercostal keelson extends above top of floors.

3. MIDDLE LINE KEELSON ON TOP OF FLOORS.

When this type of keelson is used they are to have double top angles with a rider plate, and be secured to a horizontal plate stringer on top of floors at the center line with double angle bars riveted back to back embracing said vertical keelson. Said plate stringer is to be in width 3-4 the center depth of midship floors, and is to extend for at least 3-4 length amidships. Butt straps of rider plate are to be on top; those of stringer plate on under side. When said keelson is or over 30 inches high it is to have vertical stiffening angles under all hold stanchions. Said stiffeners are to be joggled over the top and bottom bars.

4. FLAT PLATE KEELS WITH VERTICAL MIDDLE LINE KEELSONS.

(1). When the second number is or above 30,000, the flat plate keels must be doubled for 3-5 length amidships. The doubling plates are to equal the thickness of the garboards. They are to be fitted with a continuous or an intercostal vertical keelson. Flat plate keels are to maintain their midship weight for 1-2 length amidships.

(2). The middle line vertical keelson is to be double clipped to floors and be secured to the keel plates with continuous double angles for a continuous keelson, but with double intercostal clips for an intercostal keelson. The top of a continuous middle line keelson is to be worked as stated under 5-1-b; that of an intercostal middle line keelson as stated under 5-2.

5. CENTER LINE KEELSONS OF SMALL VESSELS.

They can be built of two angle bars riveted back to back on top of floors; or of a "T" bar or "I" beam section of equal area. A bulb plate may be riveted between said keelson bars in lieu of a plate keelson in those vessels whose second number is not over 5,000.

6. All center line continuous or intercostal plate keelsons, and all vertical keelsons on top of the horizontal plate stringers on top of floors, are to extend as far fore and aft as possible. The horizontal plate stringers on top of floors fitted to intercostal middle line keelsons should extend 3-5 vessel's length amidships; but when they are fitted to a "Middle line keelson on top of floors" they shall extend only for 3-4 length amidships.

7. Vertical flanges of the lower keelson bars and horizontal flanges of the top keelson bars are to be the longest.

6. Frames.

1. All frames should extend in one piece (except in double-bottom vessels) from the keel to the decks specified in Table 2. They should maintain their midship scantlings for 3-5 length amidships.

2. All water-tight bulkhead frames should be worked double. Scarph pieces when used (to be used except when a continuous middle line vertical keelson is fitted) are to be from 3 to 6 feet long, and fitted to every frame for at least 3-4 length amidships. At extreme ends of the ship the lower part of the frames should be lapped and riveted to each other.

3. When the reverse bars are cut at the margin plate of the inner bottom plating the frames are to be worked double at said point.

7. Floor Plates.

1. Floor plates are to be fitted to every frame throughout the ship. For 1-4 length amidships they must extend up the bilges above top of the keel plate to at least twice their center depth; but 2 1-2 times said depth in deep-framed vessels for 1-2 length amidships. At the lower turn of the bilge they must be at least 1-2 their center depth, and at ends equal to the moulding of the frame. Fore and aft said 1-4 length, said height at the bilge may be reduced until the floors become straight on top, but no floor is to be of less depth at the center line than midship floors. At extreme ends of the ship they are to be made deeper in order to securely fasten the sides of the ship together. Engine-room floors which are or over 1 1-3 times depth of midship floors may be finished straight on top from bilge to bilge.

2. Floors are to be secured to all center line keelsons with double clips equal to reverse bars. They are to maintain their midship weight for 1-2 length amidships.

3. Bulkhead floor plates are to extend above the ordinary floors so as to provide a sufficient lap for the riveting of the bulkhead plates to said floors above the reverse bars.

4. Limber holes shall be cut in all floors so as to provide a ready drainage for the bilge water.

5. TRANSOM FLOORS. They are to be at the center line 1 1-3 times the depth of midship floors. If less than 15 inches in depth they are to be secured to fore side of the rudder post with tap rivets, but if 15 inches or over in depth they are to have double clips, equal to the frame bars, to said post.

8. Reverse Bars.

1. Said bars are to be fitted to the top of every floor plate, and are to maintain their midship scantling throughout.

2. Reverse bars must be worked double on all floors throughout the machinery spaces and in the coal bunkers located between the boiler and engine room. Said double reverse bars are to extend from bilge to bilge.

TABLE 2.—EXTENT OF FRAMES AND REVERSE BARS.

Type of Ship.	Frames.	Reverse Bars.
One-deck vessels.................	All to upper deck.................	Under 13′ depth: to upper turn of bilge and to upper deck alternately. 13′ under 17′ depth: to U D and to one foot above the U B S alternately. 17′ depth and over with hold beams or web frames: to H S and U D, alternately.
Two- " "	" " " "	To upper and second decks alternately.
Three- " "	" " " "	c. To U D and S D alternately for $\frac{5}{6}$ length from stern. To U D on every frame for $\frac{1}{6}$ length from stem.
Ocean going hurricane-deck vessels.	" " hurricane deck.............	c. To H D and S D alternately for $\frac{5}{6}$ length from stern. To H D on every frame for $\frac{1}{6}$ length from stem.
Coastwise hurricane-deck vessels.	b. To H D and S D on alternate frames for $\frac{4}{5}$ length from stern. Forward frames all to H D.	c. To S D for $\frac{4}{5}$ length from stern. To H D and S D alternately for $\frac{1}{5}$ length from stem. Second number 25,000 or over to S D and H D alternately throughout.
In way of raised quarter or raised fore decks.	All to said decks.................	
In way of full poops and enclosed bridge houses.	a. All to said decks.	c. All to main deck.
In way of topgallant forecastle deck.	All to said decks..........	c. Alternately to said deck.
Sailing vessels, 20 feet or over in depth.	" " upper deck............	All to upper deck.

H D = hurricane deck. U D = upper deck. S D = second deck (deck next below upper or hurricane deck).
U B S = upper bilge stringer. H S = hold stringer.

a. Alternate frames only to said decks when partial bulkheads are fitted in said spaces.

b. c. Extent of said $\frac{1}{5}$ and $\frac{1}{6}$ length need not exceed 60 feet from stem.

c. A double angle bar side stringer may be substituted in lieu of running the reverse bar up at said $\frac{1}{6}$ and $\frac{1}{5}$ length forward, and in poop and enclosed bridge house and topgallant forecastle deck spaces.

When a rounded gunwale is adopted the frames are to extend to lower part of said rounded gunwale.

The above hurricane-deck vessels to be of the type having a continuous hurricane deck all fore and aft.

When the height from top of deck planking to upper side of the deck beam of the hurricane deck, exceeds 8 feet, the reverse bars on alternate frames must extend to said hurricane deck in all hurricane-deck vessels. Or else a double angle bar stringer is to be worked between decks, clipped to frames, and to shell where alternate frames are not extended to hurricane deck. Or web frames may be fitted at 6 or 8 frame spaces apart, secured to deck beams at top; and to deck plating at bottom with clips equal to reverse bars.

TABLE 3.—EXTENT OF REVERSE BARS IN DEEP-FRAMED VESSELS.

One- and Two-Deck Vessels.	Three-Deck Vessels.	Hurricane-Deck Vessels.	In Way of a Raised Quarter or of a Raised Fore Deck.
All to upper deck.....	To upper deck and to top of the second deck stringer angle bar alternately.	To top of the second deck stringer angle bar on all frames.	All to said decks.

9. Bilge Floor Keelsons and Side Stringers.

1. Bilge Keelsons.

All vessels are to have bilge keelsons of two angle bars, riveted back to back, at the upper and lower turns of the bilge.

2. Floor Keelsons.

a. All vessels whose beam exceeds 32 feet are to have a double angle bar floor keelson midway between the center line and the lower bilge keelson with intercostal plates riveted between the two keelson angles. Said intercostal plates are to have single clips to floors and to shell of reverse bar size.

b. Vessels of 20 and less than 32-foot beam without said intercostal plates are to have intercostal wash-plates in lieu of same, secured to the shell plating with a single clip equal to reverse bars.

3. Side Stringers. See Table 5.

4. When the bilge or the floor keelsons with intercostal plates are to be reinforced with a bulb plate, in lieu of said bulb plate one of the keelson angles may be changed to a bulb angle if the intercostal plates are made two pounds heavier than otherwise.

5. Discontinuous side and bilge angle keelsons and plate side stringers should lap each other sufficiently so as to maintain the longitudinal strength of the ship.

10. Floor Clips.

Floor clips for all plate stringers and keelson bars should be fitted on every frame for at least 3-4 length amidships in addition to the regular reverse bars.

11. Continuity of Stringers.

All the middle line, floor, and bilge keelsons should be worked continuous through the water-tight bulkheads, with water-tight collars on each side of said bulkheads.

12. Web or Plate Side Stringers.

Said stringers must be clipped to the shell with single clips and have a continuous angle bar at the face of the frames riveted to the stringer and to the reverse bars or clips on the frames. At ends of the ship flanged plates may be used in lieu of said shell clips. Said side stringers are to be worked continuously through the water-tight bulkheads and they shall be secured to same with double clips equal to reverse bars. Bracket knees of the same weight as the stringer plate are to be fitted at alternate frames, being clipped to the stringer plate with single clips equal to reverse bars. A single face bar is to be worked on the inner edge of the stringer plate when said plate is 30 inches or less in width. Otherwise a double face bar is to be used. The deep flanges are to be worked vertically for single face bars and horizontally for double face bars. Gusset plates are to be worked at each hold beam.

13. Web Frames with Deep Side Stringers in Lieu of Hold Beams.

The web frame plating should be at least of the same thickness as the standing flange of the frame bar to which they are attached, and be in width not less than 3 1-2 times the depth of said flange. They should have double reverse bars on the inner edge; the doubling bar extending on top of floors to one foot beyond the bilge keelson. They should be cut at all plate stringers, and have double clips to same, equal to reverse bars. They should be spaced at 3-4 of the spacing of the hold beams they are substituted for; but in no case need they be spaced closer than 8 feet.

14. Deep Framing for Vessels in Lieu of Web Frames.

1. The deep frame reverse angles are to have at least a 2 1-2-inch lap to the frame, but not less than 3 inches if the first number is 67 or over.

2. The plate side stringers are to be clipped to the shell with single clips equal to reverse bars. Continuous double angle bars are to be worked at the inside of the frames, being riveted to the reverse frame and to a reverse clip on each frame, and on the inner edge of the plate stringer. When the second number is 42,000 or above, a face plate, all fore and aft, is to be worked on the face bars on the inner edge of the plate stringer.

3. When the side stringers are cut at a water-tight bulkhead, they shall have bracket plates 3 pounds heavier than the stringer plates to same. Said bracket plates are to be in a fore-and-aft direction, not less than 1 1-2 times the width of the stringer plate; and on the bulkhead inside of the stringer plate not less than twice the width of said plate; with double clips to the bulkhead equal to reverse bars.

TABLE 4.—NUMBER OF PLATE SIDE STRINGERS.

Depth from top of floors to top of lowest beam tier amidships....	Under 15 ft.	15 ft. under 20 ft.	20 ft. under 25 ft.
Number of plate side stringers....	1	2	3

15. Deck and Hold Beams.

1. Said beams should be located vertically over each other on alternate frames, except as stated below.

2. Beams for a wood deck, or for a steel deck covered with wood, are to be placed on alternate frames.

3. Beams for a steel deck of 14 pounds or less, with no wood deck laid thereon, are to be spaced on every frame; but on alternate frames when said plating is 14 pounds or above.

4. Beams over 70 feet in length must be spaced on every frame.

5. Beams should be worked on every frame if possible in the engine and boiler spaces.

6. Beams without decking, except hold beams, are to be 1-8 deeper than otherwise.

7. Beams under the windlass, capstan, at mast partners, etc., are to be of midship size.

8. Beams at the ends of hatches or other deck openings over 12 feet in length should be 1 inch deeper than otherwise; the fore-and-afters being of the same depth as the end beams.

9. Web or plate beams are to have double angle bars worked on the lower and upper edges.

TABLE 5.—ARRANGEMENT OF DECK BEAMS AND HOLD STRINGERS.

Deck Beams.		Hold Beams and Stringers.		
a. Depth to top of Upper-Deck Beams Amidships.	b. Number of Tiers of Deck Beams on Alternate Frames.	Depth to Lowest Tier of Regular Deck Beams.	Beam Spacing.	Type of Stringer.
Under 24′	1	12′ under 14′	......	D A
24′ " 32′	2	14′ " 16′	......	D A + B P ⅝ L
32′ " 40′	3	16′ " 18′	6 Fr., 12 E	Plate
40′ " 48′	4	18′ " 21′	4 Fr., 10 E	"
....	..	21′ " 24′	Alt., 8 E	"

D A = double angle; B P ⅝ L = bulb plate for ⅝ length amidships; Alt. = on alternate frames; 8 E = on every eighth frame if extra heavy beams are used; plus sign (+) means "with a."

a To second deck in hurricane-deck vessels. b. Not including hurricane-deck beams.

Depth to be measured from top of floors or inner bottom plating.

When web frames are used hold beams may be fitted further apart than herein stated.

When depth to top of midship hold beams is or over 12 feet a hold side stringer must be fitted midway between upper bilge stringer and hold beams.

16. Beam Knees.

Beam knees should be in depth not less than 2 1-2 times the depth of the beam to which they are secured, and not less than 1 1-2 times the depth of said beam across their throat. Plate knees should be 2 pounds thicker than their respective beams. In deep-frame ships, knees of the lowest deck beams are to be three times the depth of said beams.

TABLE 6.—ARRANGEMENT OF STEEL DECKS.

Second Number.	Under 19,000	19,000 under 25,000	25,000 under 30,000	30,000 under 42,000	42,000 under 48,000	48,000 and above
Number of steel decks.	No steel deck required.	One partial........	One complete......	One complete. One partial.	Two complete.....	a Three complete.

a Lower deck to be of at least 14 lbs. plating.

The Engineering Personnel in the Navy.

Editor Marine Engineering:

As a preface to his remarks on the engineering personnel of the navy, Admiral Rae in his last annual report makes the following indisputable and significant assertions:

"1. A modern navy without an efficient engineering personnel is deficient in one of its prime requisites, and will fail in the hour of battle.

"2. The present condition of engineering in the navy is a cause of grave anxiety to all conversant with the subject.

"3. No man can become an efficient engineer without a proper training and experience.

"4. The requisite training and experience cannot be obtained by serving for a few months only, and at non-consecutive periods of time, in the engineer departments of ships in commission."

To a person conversant with engineering matters as they now obtain in the navy, these statements are fraught with much that is of vital importance. Briefly stated, the machinery of the ships of the navy now in commission is kept going in a trust-to-luck manner by a handful of experienced engineer officers, a varying but small number of inexperienced and unenthusiastic line officers, and an overworked and disgruntled corps of warrant machinists. Frequent recourse to the services of the repair shops at navy yards, and the fact that the majority of the vessels are comparatively new, are the principal deterring agencies which postpone the inevitable crisis in engineering matters. The policy of the administration appears to be to keep the entire fleet in a condition of preparedness for any emergency which might arise, and aside from the conditions existing in the engineering department our vessels are undoubtedly in a high state of efficiency. But with each commander's commission handed to a former officer of the old engineer corps this state of affairs is growing worse instead of better. What will happen when all these officers are retired from sea duty is a matter of the gravest conjecture; that time is not far distant, and something must be done. The hallucination that every line officer could be made a capable engineer officer by merely spending a few months in an engine room and telling the machinist of the watch to "Make it so," has disappeared even from the minds of the fathers of that legislative monstrosity, the so-called "Personnel Bill." The remedial measures proposed by Admiral Rae for the enlargement and training of the commissioned personnel would no doubt be of great benefit, but would they, even in their entirety, furnish a complete solution of the problem? Assuming for the moment that these measures would result in an efficient engineer corps, what has been done in regard to their being promulgated? We hear of a proposed re-organization of the personnel of the navy (a bill recently introduced in Congress) which will provide for various vice-admirals, early retirements from sea duty of captains, commanders, etc., but where is the legislation for the most vital question which confronts the navy to-day? *Tempus fugit,* and the crisis is close at hand. If nothing is to done for the commissioned personnel from an engineering standpoint, and present appearances would give one that impression, why not make the best of the present situation and do something for those who are now acting as engineers, the present corps of warrant machinists? The officers of the departed "Engineer Corps" forsook the title of "Engineer" for the higher sounding appellations (from a social standpoint only) of "Lieutenant," "Commander," "Captain," "Admiral," etc.; why not give it to those who are now doing the engineering work? "Warrant machinist" means nothing. Call them assistant engineers and be done with it. Can anyone deny the relative importance of the man in charge of an engine-room watch, especially when compared with a boatswain, gunner, carpenter, and even those relics of a musty past, the sailmakers? Then by all means give the "man below" the privilege of aspiring to that reluctantly granted title of "Withbutafter" ensign; but please note that the emphasis is always on the "after." Then, too, why not increase the number of these hard-working men, so that eventually all will not become web-footed by constant service at sea? Going to sea is not a bed of roses by any means, and warrant machinists, as well as commissioned officers, have wives and sweethearts whom they would like to see occasionally. Because nothing can seemingly be done to reorganize a competent commissioned engineer corps, there is no good reason why every effort should not be made toward making the best of existing circumstances, and the first step would seem to be to make the present warrant machinists satisfied with their lot by granting their reasonable requests. No man dissatisfied with his position can or will fill the same efficiently. All true friends of the navy will, I feel sure, agree with me that something will have to be done for the engineering side of the navy, and that soon. While I may be classed as a pessimist for thus expressing my views, all must admit that the situation is a grave one. The voice of the press is the one that is listened to most attentively in this great country of ours, and I appeal to you to sound the alarm through the columns of your paper, which, without any intention of flattery, I believe to be the leading exponent of engineering matters, from a marine standpoint, in this country.

Very truly yours,

Ex-Volunteer, U. S. N.

San Francisco, Cal., Feb. 2, 1905.

OBITUARY.

We have to record the death, on the 25th of January, of Mr. Edward H. Mullin, of Millburn, N. J. Mr. Mullin was very prominently connected with electrical engineering work, both by his position with the General Company in New York, and his membership in the American Institute of Electrical Engineers. An Englishman by birth, he was a graduate of Queens College at Belfast and of the University of Edinburgh.

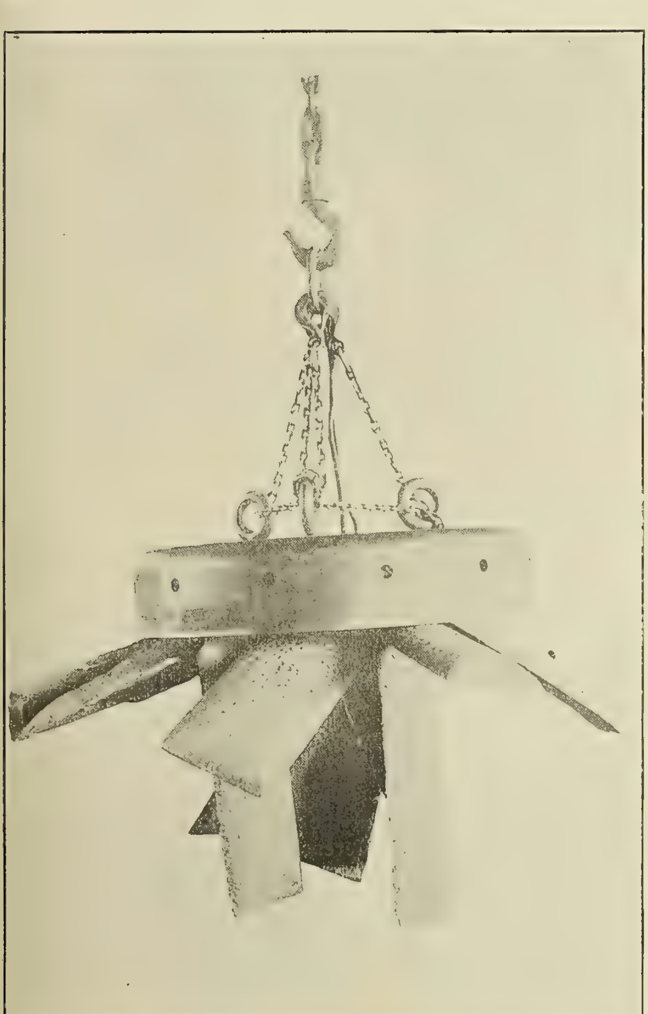
ENGINEERING SPECIALTIES.

Electro-Lifting Magnets.

Wherever steel or iron is handled in quantities by means of cranes, a magnet will effect economies in time and labor sufficient to pay for itself in from one to six months. This statement is borne out by experience in steel mills, jobbing houses, safe works,

etc., and is evident when the methods, chain versus magnet, are compared. In all cases an electro-magnet is used, suspended from the hook of the crane, direct current at any of the common voltages being employed to energize the magnet. A flexible twin conductor cable is used to convey the current to the magnet and a small switch operated by the crane man is usually the only additional apparatus necessary. The amount of current used is small, being from one to twelve amperes according to the service for which the magnet is designed.

In operation the magnet is lowered upon the material to be lifted, and the switch closed, thus causing the magnet to attract and hold the material, which may then be hoisted by the crane and transported to the desired point. By simply opening the switch the material is instantly released. Comparing this method of operation with the common methods of connecting the load to the hook of the crane, with chains, hooks or clamps, the saving in both labor and time is apparent, as, in general, the attachment of the magnet to the load, as well as the release of the load, may be accomplished by the crane operator without assistance, thus saving the labor of one or more men for prying up the material, attaching hooks and chains at the point of loading, and additional men at the point of delivery for unhooking the load from the crane.



Magnets can be so quickly attached to and detached from a load that by their use the work which may be done by a given crane is greatly increased—in some cases more than doubled. It frequently occurs that the attachment of lifting magnets to existing cranes so increases their capacity for handling material that the purchase of additional cranes for handling an increased output is rendered unnecessary.

Again, lifting magnets require much less head-room than hooks or chains for lifting material of considerable width such as steel plates. Therefore, by the use of magnets material can be conveniently piled to a greater height in the storage space under a given crane than is possible when chains are used, thus increasing the capacity of a given storage space without altering the crane runway or increasing the size of the building.

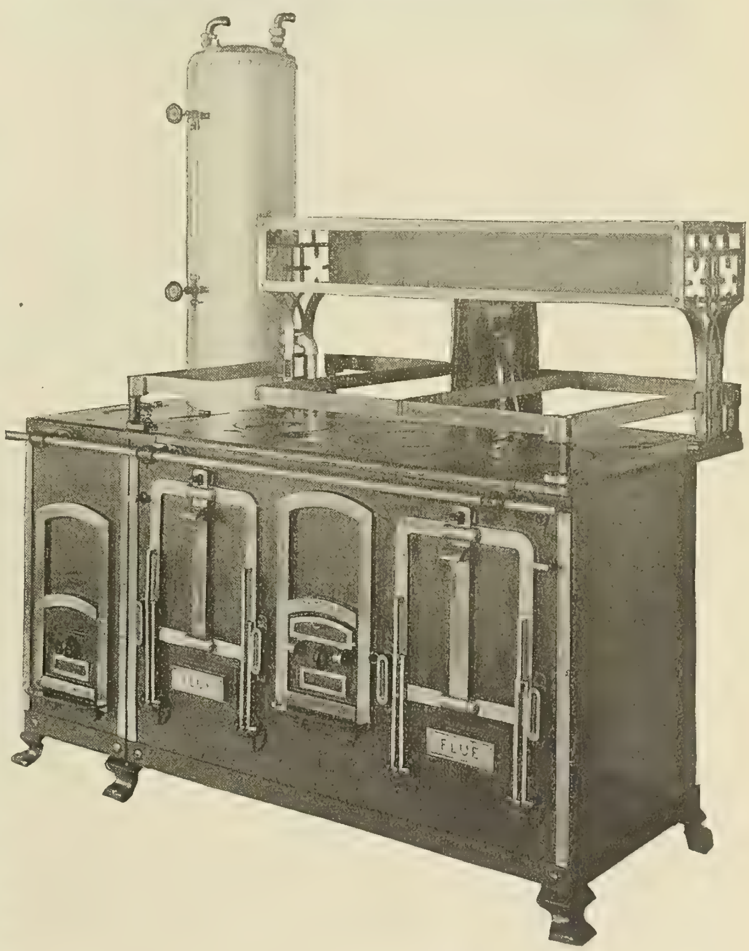
Lifting magnets may be used to great advantage in handling pig iron, scrap, rivets, bolts and similar articles in bulk, as shown in the illustrations. Ingots, blooms, slabs, billets, bars, plates, rails, structural shapes, pipe, etc., may also be handled to advantage. The Illinois Steel Company use fourteen magnets in their South Chicago works alone, and have found the economy in time and labor so substantial that they have decided to use them wherever possible in all their works.

A single design of magnet is not adapted to handling the full range of material above mentioned; on the contrary, the magnet must in every case be designed to meet the form of material to be handled. For instance, there is a wide difference in the design of a magnet for lifting ingots or blooms and one adapted to the handling of thin plates. A magnet which would handle five tons in the form of an ingot might not handle 500 pounds in the form of thin plates. It is therefore necessary to understand in each case the operating conditions with special reference to the form and range of material to be handled.

The question of risk of accident rises. The Electric Controller and Supply Company, Cleveland, O., report that in their experience with scores of lifting magnets in successful operation they have yet to learn of a single accident which has occurred through their use; while, on the other hand, accidents due to the slipping and breaking of hooks and chains are known to be of very frequent occurrence. Magnets are always built and tested to from four to five times the specified load.

Webb Galley Range.

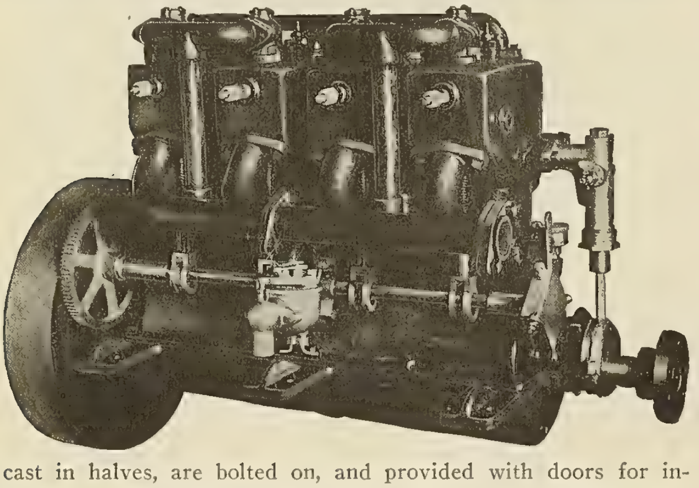
We reproduce herewith a cut of a type of galley range manufactured by Elisha Webb & Son, Philadelphia, Pa., which is rapidly gaining favor with the ship owners because of the con-



venience its use insures where installations are made. The apparatus consists of a modern steel range, with coal box, having a circulating hot-water boiler used in connection with the water-back in the fire-box, which by an ingenious system of piping insures hot water in any desired quantity at any place on shipboard, under a pressure or gravity system. These ranges have been installed by the makers on a number of vessels of the Standard Oil Company, the 20-knot passenger steamers *Penn* and *Lord Baltimore,* harbor-master's tug *M. S. Quay,* and dredges *Atlantic, Benyaurd* and *Burton.* The cut reproduced shows the type of apparatus made for and installed on the five United States light vessels built by the New York Shipbuilding Company, which consisted of a 4-foot, two-oven range and circulating hot-water boiler of fifty gallons' capacity, making a complete and very satisfactory galley outfit for a vessel of this class.

The Hoffman Motor.

The design of the Hoffman motor, built by the H. L. Hoffman Motor Company, of 394 Wabash avenue, Chicago, Ill., is the outcome of years of experience. Each cylinder head, water jacket, and valve chamber is cast all in one piece. The crank chambers,



cast in halves, are bolted on, and provided with doors for inspection. The flywheels are outside. Under these specifications a motor can be built very inexpensively, and will stand hard service. The motors are all operated on the four-cycle system.

The four-cylinder motor shown in illustration develops 12 horse power with cylinder 4 inches in diameter and a 5-inch stroke. The weight of the engine complete is stated to be 550 pounds, and it is designed for the use of launches from 25 to 35 feet in length.

The single-cylinder engine has also a 4 by 5 cylinder, developing 3 horsepower. The weight is 210 pounds, and the designed service the propulsion of launches from 16 to 21 feet long.

TECHNICAL PUBLICATIONS.

The Centrifugal Pump, Turbines, and Water Motors: including the Theory and Practice of Hydraulics. (Specially adapted for engineers). By Charles H. Innes, M.A., Lecturer on Engineering at Rutherford College, Newcastle-on-Tyne. Fourth and enlarged edition. Pages 340. Figures 276. Price $2.00. 1904. Manchester: The Technical Publishing Company, Limited, and New York: D. Van Nostrand Company, and The Derry-Collard Company.

Commencing with the assumption of the law of the conservation of energy, and afterwards assuming the law that the change of angular momentum is equal to the angular impulse of the force producing it, and that the losses of energy in a stream are proportional to the square of the velocity of flow, the author has developed the theory of operation and methods of design of the machines included in the title. The first few chapters are devoted to the exposition of the fundamental principles of the science of hydraulics. In the sixth chapter, however, the author, having "always found that theoretical principles, although absolutely necessary, are best administered in small doses, turns from them to describe a few types of hydraulic engines for producing rotation." Carried along with each description are the theory governing the case in question, and its application to the design in hand. The turbine is taken up both graphically and by methods of calculation, the latter being given the preference on account of its greater accuracy, and only slightly increased demand upon the time of the engineer. Under the head of "impulse turbines" is given the Pelton wheel, so common in the United States, and so rarely met in Europe.

The theory of the centrifugal pump is based on the assumption, for the sake of simplicity, that the axis of rotation is vertical, it being obvious that, otherwise, "particles at equal distances from the shaft would have different velocities and be under different pressures, which would complicate the theory, although the effect in practice is unimportant." Comparisons are made, for both centrifugal pumps and turbines, between theory and the results of experimental practice, a large number of experimental results being tabulated and represented by the usual curves of performance.

Chapters are given to the more or less closely allied subjects of the steam turbine, and the centrifugal fan, while one of the last chapters in the book is devoted to a description of the plant and hydraulic apparatus of the Niagara Falls Power Company. The only steam turbine accorded extended mention is the Parsons.

The numerous cuts, which serve to illustrate and explain the text, are quite clear, though many of them are relatively crude. The typography is good.

Record of American and Foreign Shipping. Pp. 1,294. Size 8 by 9 1-2 inches. Price $15.00. American Bureau of Shipping, 66 Beaver street, New York.

The price of this book was given in our February number as $5.00, which is incorrect.

Types and Details of Bridge Construction. Part I.—Arch Spans. By Frank W. Skinner, M. Am. Soc. C. E. Pages 299, and 250 illustrations. 1904, New York: McGraw Publishing Company.

The purpose of this book is to present the development of advanced practice and standard details, to illustrate the classes of structures adapted to different conditions, show some of the characteristic differences between American and foreign design, besides recording important and well-known examples so as to have their principal data readily accessible. The first consideration in the selection and preparation of this data has been in every case to show clearly the special and important features, to give only what is essential to the design, and to present the requirements, conditions, and methods involved in the construction and erection of the work. The list of structures described is by no means complete, and the classification is not absolute, but both are sufficient to illustrate different types and to show a wide range of practice and detail. The bridges have been arranged in order and grouped in classes, and the descriptions are in many cases supplemented by specific references to more extended articles in technical journals or professional papers. Typography and illustrations leave little to be desired.

Maver's Wireless Telegraphy. By William Maver, Jr. 216 pages; 123 illustrations. 1904, New York: Maver Publishing Company. Price $2.00.

The subject has been treated from both the theoretical and the practical standpoint in language as free as possible from mathematical formulæ, and the whole written in a manner designed to be clear to the average reader. The intention has been, in order to economize in space, to limit the descriptions of systems and apparatus to those in actual operation. The few exceptions to this rule relate to peculiar types of systems of which a brief account was thought to be useful. The aim has been to give a comprehensive statement of all that appertains to the art at the present time, and in the hope of supplying a complete and practical handbook of wireless telegraphy. The first part of the book was written when there was but one wireless system in operation. It may, therefore, be said that the book has grown up with the art of which it treats. This has necessitated considerable cross reference in the text, and has resulted in the inclusion in the volume of an unusually complete index.

QUERIES AND ANSWERS.

All reasonable questions concerning marine engineering received from and signed by subscribers will be answered by the editor in this column. All communications must bear the name and address of the writer.

Q. 272.—(1) If a cylindrical shell be subject to an internal pressure of 100 pounds to the square inch, and being 40 inches in diameter and 120 inches long, what will be the stress per square inch on the longitudinal and circumferential seams; also, which one of these two has to made the stronger?

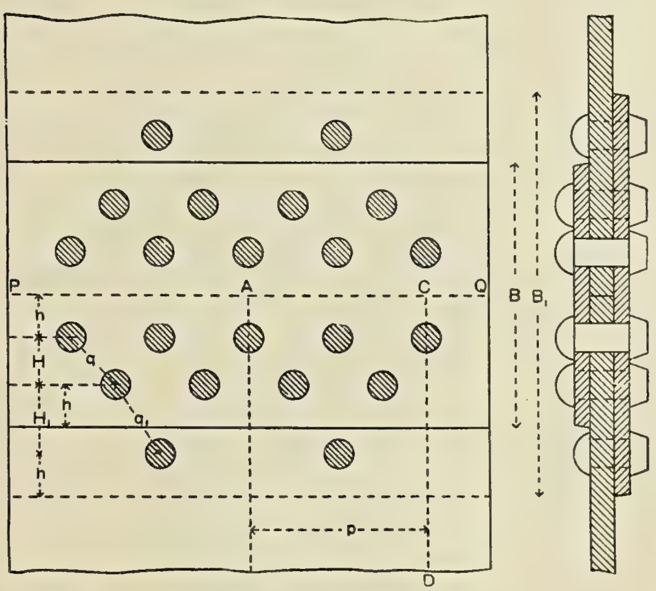
(2) Taking a rivet in single shear at 40,000 pounds and in double shear 75,000 pounds per square inch of section, please give method of analysis of butt seams, double strapped, having two rows of rivets in double shear, and one row in double pitch and single shear as below. Plate, 65,000 pounds tensile strength per square inch; thickness, 1-2 inch; thickness of strap, 5-16 inch; diameter of rivet holes, 13-16 inch; single pitch, 3 1-4 inches; double pitch, 6 1-2 inches. Oiler.

A.—(1) The stress along the longitudinal seam of a cylinder subject to internal pressure is represented by the pressure per square inch multiplied by the diameter of the cylinder and divided by twice the thickness of the shell. For a circumferential seam, the stress per square inch is represented by the internal pressure in pounds per square inch multiplied by the diameter and divided by four times the thickness of the plate. It thus appears that it is necessary to make longitudinal seams stronger than circumferential seams, because of the fact that under similar conditions the stress will be greater. In the example given, the thickness of the plate is not mentioned. Assuming it to be 1-2 inch, it follows that the stress per square inch in the longitudinal seam equals:

$$\frac{100 \times 40}{2 \times \text{1-2}} = 4{,}000 \text{ pounds per square inch,}$$

while the stress on the circumferential seam will be:

$$\frac{100 \times 40}{4 \times \text{1-2}} = 2{,}000 \text{ pounds per square inch.}$$



(2) The strength of a riveted joint is determined by the weaker of the two elements making up that joint, the plate, and the rivets. These are usually made about equal in strength; where any difference is made between them the plate is made the stronger because of the fact that it is more subject to corrosion. A riveted joint may fail in any one of four ways: (*a*) by tearing out the plate along the line of rivets; (*b*) by shearing off the rivets; (*c*) by splitting the plate between the rivet holes and the edge; and (*d*) by splitting the plate in diagonal lines along a row of "staggered" rivets. In the present case only the first two are applicable.

(*a*) Let us take for consideration a section of length, p, which is just like every other such section along the seam. In that section we find that there are two places in each of which two rivet holes are in line. This reduces the effective area of the plate to:

$$t \times (p - 2d),$$

where t is the thickness of the plate in inches, p the pitch of the rivets or distance between their centers, and d the diameter of the rivet holes. If we multiply this expression by the tensile strength of the material, T, we have as the strength of the plate in its weakest section:

$$T \times t \times (p - 2d).$$

With the data given, this figures out as:

$$65{,}000 \times \text{1-2} \times (6\ \text{1-2} - 2 \times \text{13-16}) = 158{,}438 \text{ pounds.}$$

(*b*) In the section in question there are four rivets in double shear and one in single shear. As the rivet holes are 13-16 of an inch in diameter, the rivets would be made 3-4 of an inch, allowing 1-16 of an inch clearance for the insertion of the rivets when hot. The cross sectional area of each rivet is:

$$\text{3-4} \times \text{3-4} \times \frac{\pi}{4} = 0.442 \text{ square inch.}$$

Thus the five rivets in question will have a shearing strength represented by:

$$0.442 \times (40{,}000 + 4 \times 75{,}000) = 150{,}280 \text{ pounds.}$$

It is thus seen that general practice has been followed in making the plate a little stronger than the rivets.

Q. 273.—Will you please figure the horsepower on the following gasoline engines, and explain it in Marine Engineering?

The engines are of the 4-cycle type and of the best makes. (1) 2 cylinder; diameter, 7 inches; stroke, 9 inches; revolutions, 320. (2) 2 cylinder; diameter, 8 1-8 inches; stroke, 10 inches; revolutions, 350. (3) 4 cylinder; diameter, 6 inches; stroke, 8 inches; revolutions, 300.

We do not know the M. E. P. on the cylinders, but figure them at 80 pounds per square inch. Gasoline Engine.

A.—(1) The area of this piston figures out at 38.5 square inches, which with 80 pounds mean effective pressure would give 3,080 pounds as the mean pressure on the piston during the power stroke. This being a four-cycle engine, and having two cylinders, there would be one power stroke for two revolutions. As there are 320 revolutions per minute, and the stroke is 9 inches, we find that the number of foot-pounds per revolution figures out at 1,155, and the foot-pounds per minute 369,800. This gives 11.2 horsepower.

(2) The piston in this case has an area of 52.85 square inches and a total average pressure during the power stroke of 4,228 pounds. As before, there is one power stroke in every two revolutions. The revolutions numbering 350 per minute with a 10-inch stroke, the work in foot-pounds per revolution figures out at 1,762, which gives 616,000 foot-pounds per minute, or 18.65 horsepower.

(3) In this case the piston area is 28.25 square inches, the pressure on piston 2,260 pounds, and as there are 4 cylinders there will be one power stroke in every revolution. The revolutions per minute number 300 while the stroke is 8 inches. The work per revolution is, therefore, 1,507 foot-pounds. This gives 452,100 foot-pounds per minute, or 13.7 horsepower.

Q. 279.—Will you kindly give me the required information through your Q. & A. column as per the following questions?

Give the drawing-board delineation of the method used in laying out worms and worm wheels, used for turning gear, together with the rules regulating the proportions of teeth and thread, and the depth of same, etc.

What is a good hand book on machine design? G. F. M.

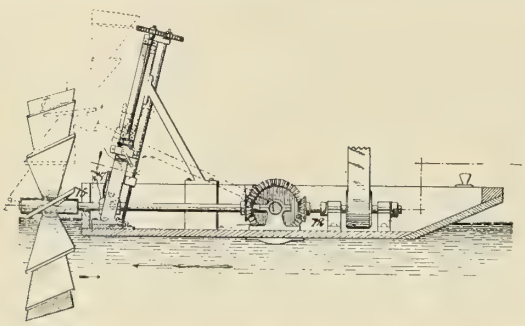
A.—The subject of worms and worm-gears is taken up on page 395 of "Machinist's and Draftsman's Handbook," by Peder Lobben, published by Van Nostrand Company, New York, in 1900, the price of the book being $2.50. This appears to be a good book on the general subject of machine design from the standpoint of the draftsman.

SELECTED MARINE PATENTS.

775,164. APPARATUS FOR LOADING VESSELS WITH COAL OR OTHER MATERIAL. CHARLES BROWN, LIVERPOOL, ENGLAND, ASSIGNOR OF ONE-THIRD TO WILLIAM HAROLD WATSON, GREAT CROSBY, ENGLAND.

Claim.—1. In an apparatus for loading vessels, the combination of a barge for holding the material to be loaded; means on the barge for holding it at a given distance from and in rolling contact with the vessel which is being loaded; an elevator adapted to raise the material; chutes adapted to guide said material from the elevator; a vertically-adjustable hopper designed to receive the material from the chutes; and means for feeding the elevator buckets up to the material in the barge.

7. In an apparatus for loading vessels, the combination of a barge for the material to be loaded; an elevator capable of travel longitudinally and laterally on said barge; means for moving said elevator; a third adjustable wheel near the lower extremity of the elevator adapted to adjust the travel of elevator buckets situated on said elevator, in relation to the bottom of the barge; an inclined adjustable chute situated near the upper end of the elevator; means for adjusting said chute; a counterweighted pivoted baffle at the top of said chute; a vertical hopper adjustable as to length and horizontally as to position; and means for so adjusting said hopper, substantially as and for the purpose described. Seven claims.

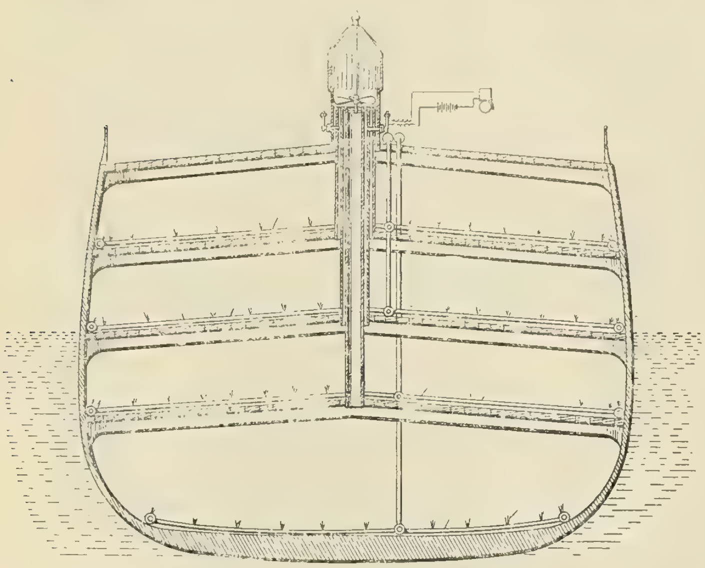


778,702. CURRENT MOTOR. WM. NIEMEYER, ST. JOSEPH, MO.

Claim.—1. A current motor comprising in combination, a water wheel, a shaft on which said wheel is mounted, a gear wheel carried by said shaft, a second gear wheel with which said first gear wheel meshes, a third gear wheel with which said second gear wheel meshes, a shaft carrying the same, means for transmitting rotation from said last shaft, a rotatable bearing for said first shaft at substantially the axis of said second gear wheel, and means for raising and lowering said first shaft about the axis of said bearing. Eight claims.

779,157. MEANS FOR EXTINGUISHING FIRES ON SHIPS. HUGO GRONWALD, BERLIN, GERMANY.

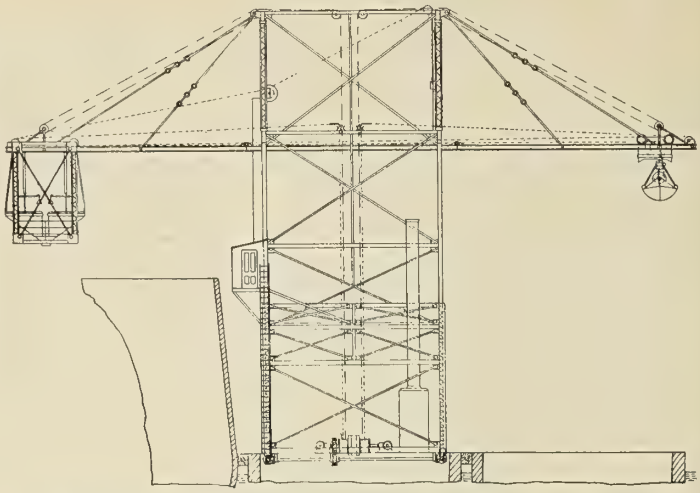
The invention is carried into practice by providing each hold of the vessel with a pipe system for introducing carbonic acid, the said system being preferably so arranged that the carbonic acid or extinguishing gas will rise from the floor of the hold or space, in combination with exit pipes having substantially the same discharge capacity or whose areas in cross section are substantially the same as those of the aggregate carbonic-acid gas inlets to



the respective compartments or holds of the vessel. Such pipes are preferably provided at the upper ends with safety valves which are adapted to be properly adjusted. The exit pipe is to serve also to let off the smoke and hot air arising in the case of a fire only to such an extent as is necessary to prevent injurious pressure, but not in such a measure as to prevent the formation of a proper mixture of air and carbonic acid. These safety escape or exit tubes preferably extend to the upper deck and are there provided with suitable thermometers and alarm devices, so that said pipes will serve also for announcing the existence of the fire and facilitating the proper observation of the condition of the same, while the extinguishing operation is proceeding from the deck. Twelve claims.

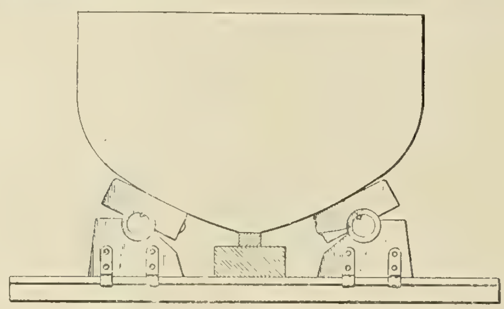
779,493. LOADING OR UNLOADING MACHINE. JOHN McMYLER, CLEVELAND, O.

Claim.—2. In a hoisting machine, the combination of a supporting frame, a tower carried thereby and having a suitable track, means for raising and lowering the tower, a pair of booms pivoted to the sides of the tower and adapted to form a continuation of the track thereon, means for raising and



lowering said booms, a trolley on such track carrying a bucket, and a hopper carried by said tower and adapted to receive the material from the bucket.

7. In a hoisting machine, the combination with a scow, of a supporting frame carried thereby, a tower arranged to be moved vertically within said frame, two pairs of tracks mounted in said tower, a pair of booms hinged to said tower and having tracks which form continuations of the tracks carried by said tower, a trolley arranged to operate upon one pair of tracks, means for operating the same, a hopper cage arranged to run upon said other pair of tracks, said trolley being arranged to travel within said hopper cage, a pair of hoppers within said cage, and weighing scales supporting each hopper. Eight claims.

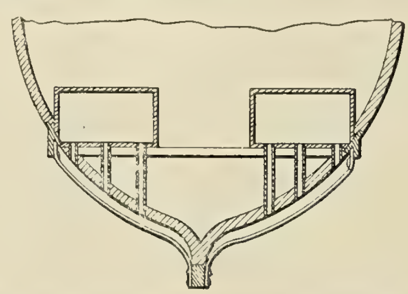


779,600. BILGE BLOCK. JOHN HICKLER, PASADENA, CAL.

Claim.—1. A bilge block comprising a base or supporting element, a tilting member counterweighted at one end and having a bearing tube secured thereto adapted to rock within the bearing surface of the supporting block, said tube having curved flanges upon its outer ends to permit a slight transverse rocking movement to compensate for irregular surfaces, substantially as described. Three claims.

780,071. BOAT AND MEANS FOR PROPELLING SAME. HERMANN STASNY, FRANKFORT-ON-THE-MAIN, GERMANY.

Abstract.—The invention relates to improvements in boats and means for propelling same, said means comprising a slide provided with movable paddles and adapted to be reciprocated longitudinally of the boat and mechanism for operating said slide, the latter being connected to an endless chain driven by a second endless chain adapted to be moved to and fro by means of a handle. Two claims.



780,122. AIR APPARATUS FOR VESSELS. HANS NELSON, CHIPPEWA FALLS, WIS.

The object of the invention is to improve the construction of the hulls of vessels and to provide means for increasing the speed of the latter by uniformly distributing a current of air, gas or similar fluid between the hull and the water in which the hull rests, thereby reducing the frictional resistance of the vessel and materially assisting the driving mechanism in propelling the boat; also to provide novel means for compressing air and forcing the same under pressure longitudinally of the hull and in a direction opposite to the direction of travel of the vessel. Four claims.

Marine Engineering

APRIL, 1905.

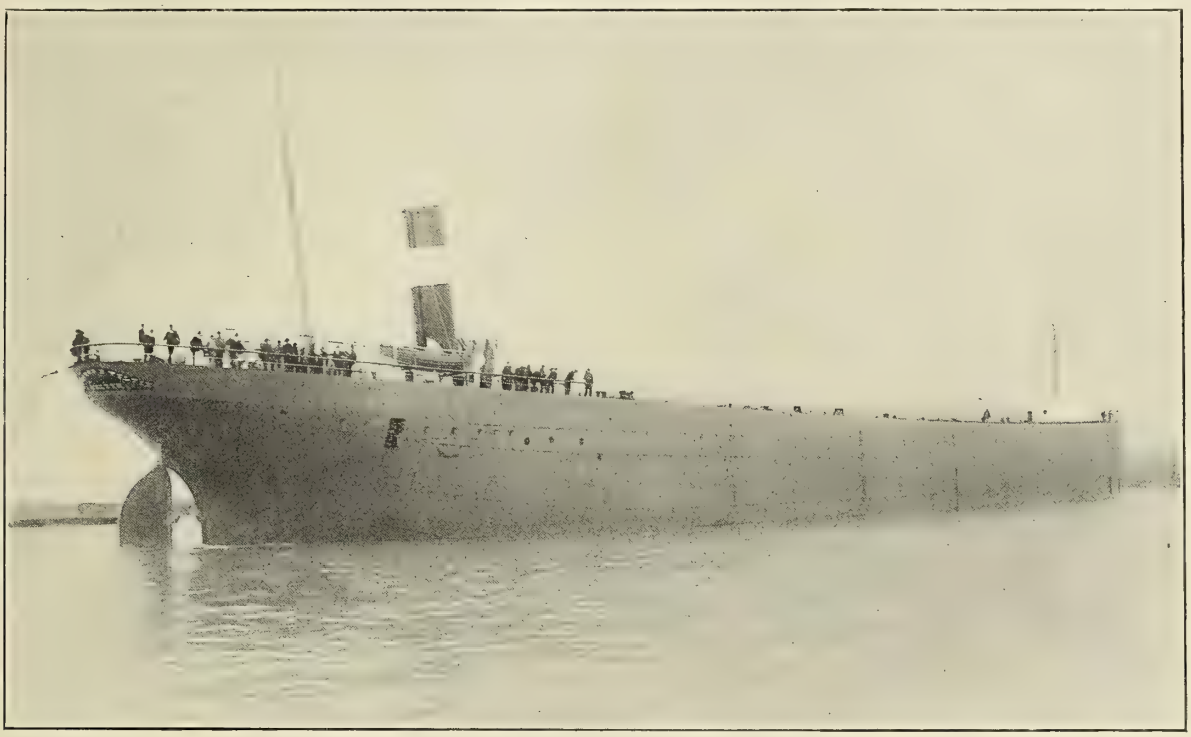
RECENT DEVELOPMENT OF LAKE SHIP BUILDING.

BY WALDON FAWCETT.

The placing of contracts for four new steel steamers, which will rank as the largest vessels ever constructed on the great lakes, emphasizes the present healthful condition of the steel ship building industry on the inland seas, and also furnishes further refutation of the contention that the fresh water cargo carrier has reached its maximum development of size under existent limitations in the depth of harbors and channels. These new freighters, and others for which contracts have recently been entered into, are of further interest by reason of the fact that they will constitute confirmation of the wisdom of certain rather radical innovations in design which were introduced by way of experiment in a preliminary vessel of this new class, turned out only a few months since.

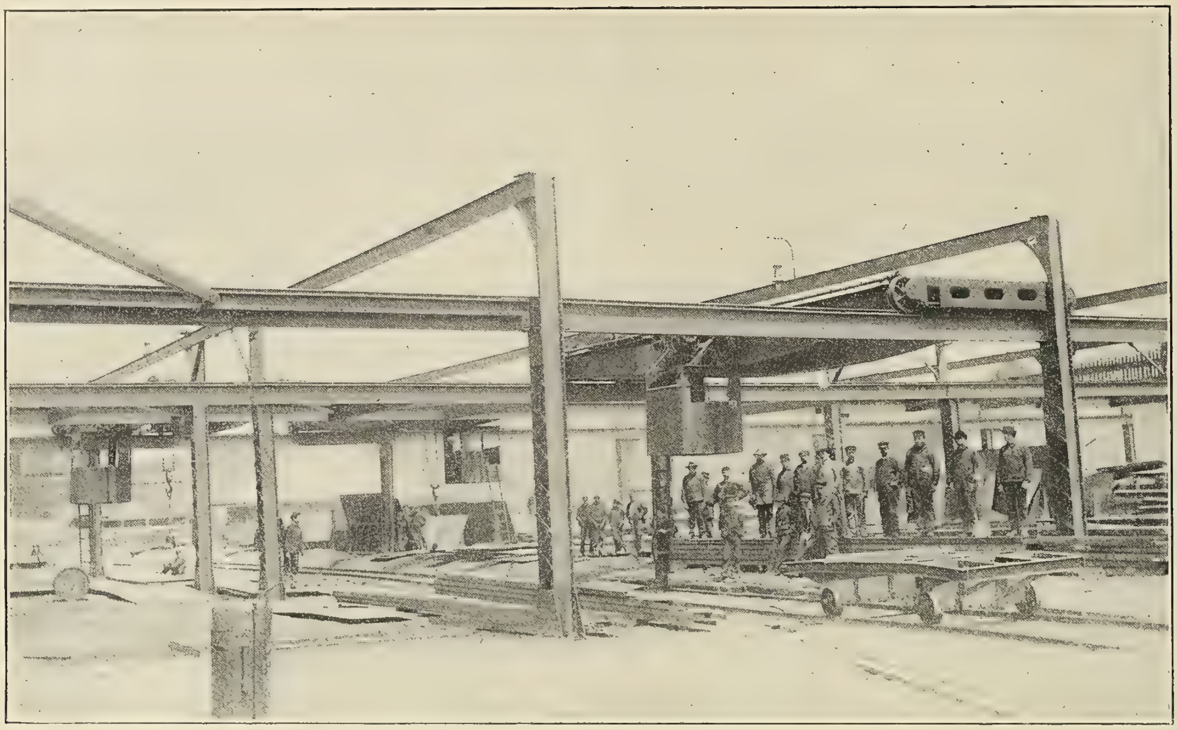
When, at the close of the last century, the management of the lake shipping interests, at that time controlled by John D. Rockefeller and his associates, entered into contract for the construction of several steel freight-carrying steamers of approximately 500 feet length over all, it was generally predicted that the acme of attainment had been reached, pending the deepening of certain waterways connecting the chain of lakes, the condition of which must ever, by reason of their positions, exert a determining influence upon lake navigation.

When the steamer *Morse* and other vessels of the Rockefeller fleet above mentioned were planned, it was claimed that the development which involved continual increase in the length and breadth of lake craft without a proportionate increase in the depth, had reached its limit. It was even predicted that progress in this direction must stop until there was available through the entire interior water highway a minimum depth of 23 feet of water, as compared with 18 or 19 feet, the average depth in the shallowest channels at that time. Moreover, so generally did this view of the situation appear to be accepted in shipping and shipbuilding circles that there was actually a revulsion of sentiment, and not only were no further contracts placed, for the time being, for vessels of the 500-foot class, but the policy of owners appeared to be to secure hulls ranging in length from 450 to 480 feet, and at this juncture not a few contracts were placed for vessels of from 436 to 450 feet.



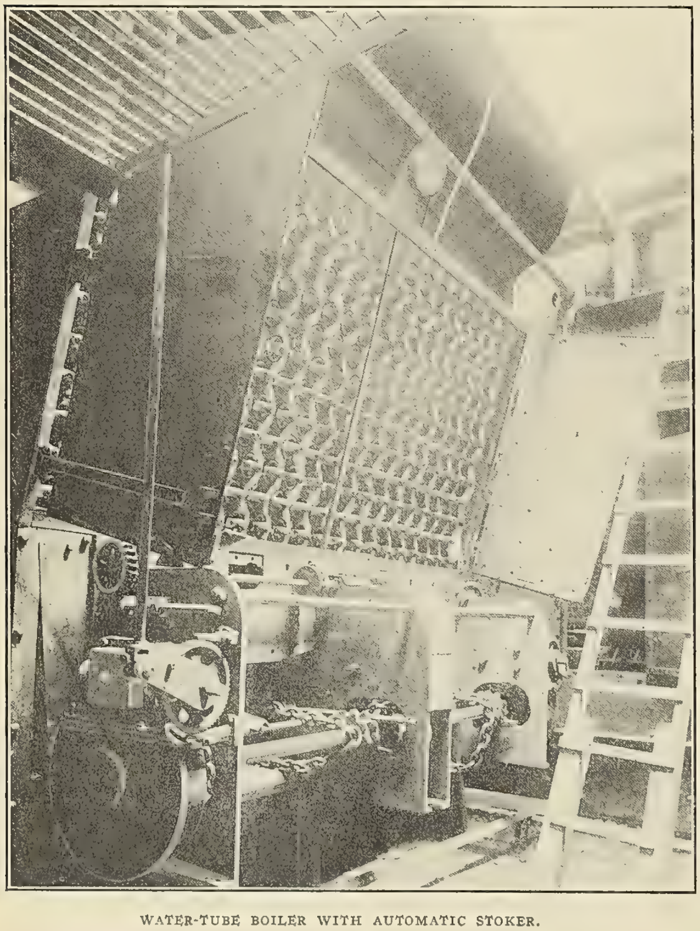
THE LAKE STEAMER AUGUSTUS B. WOLVIN.

This policy prevailed until the autumn of 1903, when the advance and development of the lake cargo carrier as a distinctive type of craft was resumed by the placing of a contract for the steamer *Augustus B. Wolvin*, a vessel 560 feet in length over all, and which ranks to-day as the largest ship in commission on fresh water anywhere on the globe. With the later increase in the size of lake vessels, however, has come a change in the methods of operation, which has in a measure made practicable the larger craft. In the days when the Rockefeller management reached the 500-foot limit in the length of ships, it was the policy of these interests to have each steamer tow one or two barges, in size nearly equal to the propeller, thus enabling one engine to move aggregate cargoes of about 20,000 tons of iron ore. Under the new *régime* this plan has been abandoned. The present-



HANDLING MATERIAL IN A LAKE SHIPYARD.

day vessel of the greatest capacity is fitted with powerful engines, but it is not contemplated that she will attempt to handle tow barges. To compensate for the economical advantage found in the movement of three cargoes by one engine, the new design is for a steamer of 40 percent greater carrying capacity than any one of the old steamers or barges; capable of being operated at greater speed; with a vastly greater factor of safety in heavy weather; and with considerable saving for tug service and other handling charges, over that necessitated by the movement of vessels without power in rivers and harbors.



WATER-TUBE BOILER WITH AUTOMATIC STOKER.

The four new steamers are to be constructed for the Pittsburg Steamship Company, which constitutes the lake navigation department of the United States Steel Corporation. The new vessels will be virtual duplicates of the steamer *Wolvin,* save in length, in which they exceed the *Wolvin* by nine feet. Their dimensions will be 569 feet length over all, 549 feet length of keel, 56 feet beam, and 31 feet depth. The new vessels will cost $430,000 each, as compared with $480,000, the cost of the *Wolvin,* but it should be explained that this difference in cost is, in part, to be attributed to the provision on the *Wolvin* of elaborately-fitted owners' quarters.

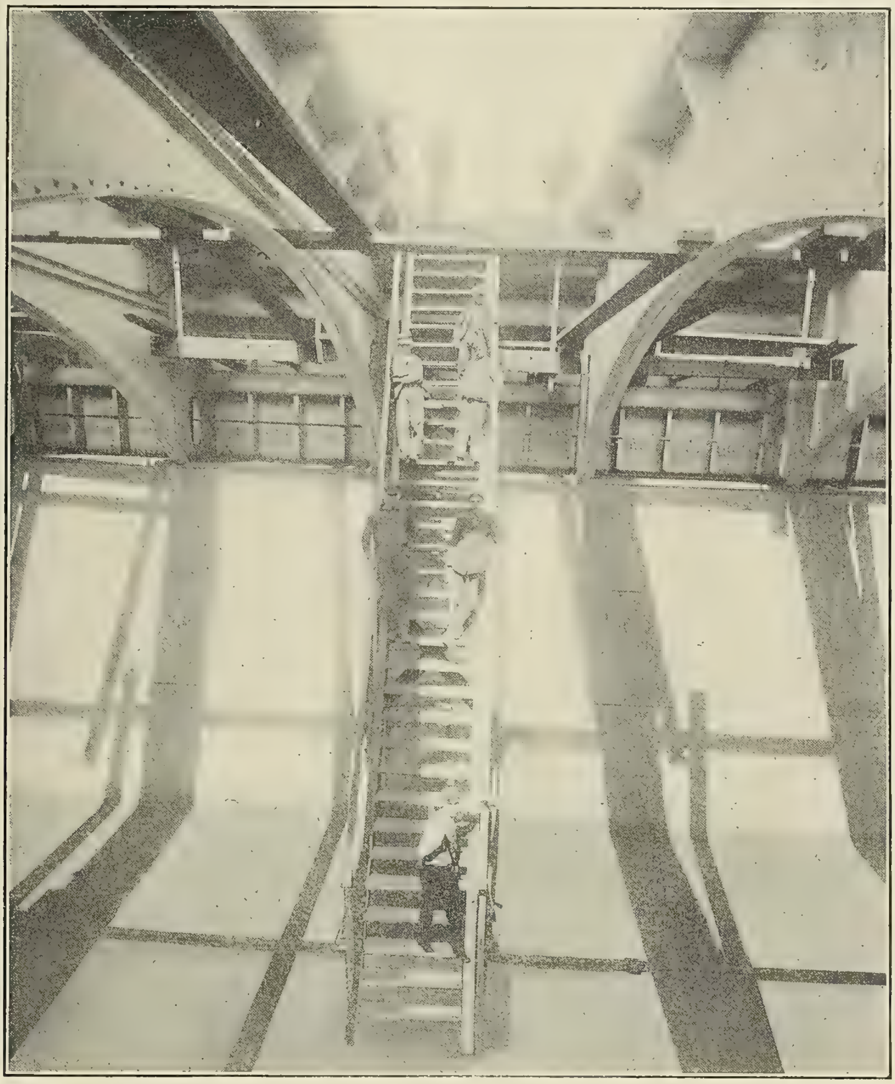
The new class of lake steamers differ very radically from the older vessels in construction. This alteration of design has not resulted in any change in the always distinctive exterior appearance of the fresh-water freighters, but is plainly manifest in the arrangement of the interior. The new principle is known as the arch-hopper construction, and was inaugurated in the *Wolvin,* where it has proven so successful as to induce adoption for the four new steamers, and probably all future vessels of this class. This novel construction has not only contributed the additional strength essential in a vessel of the length of these, but permits the employment of the clam-shell or grab-buckets, which are rapidly coming into use for the automatic unloading at lake ports of the iron ore which constitutes the chief commodity carried by these vessels.

In the new form of construction the ordinary hold stanchions found in all the older types of lake vessels are entirely dispensed with, and in their place is substituted a system of girder arches which support the upper deck as well as the sides of the vessel. The cargo hold is built in the form of a hopper with sides that slope from the main deck down to the tank top and with ends built on the same slope. The extent of this incline may be appreciated from the fact that in the case of the *Wolvin* the width of the hopper at the top is 43 feet and at the bottom only 24 feet. Obviously such an arrangement is of immense advantage where it is desired to unload cargoes almost wholly by mechanical means. The arrangement of the cargo hopper in one continuous length without bulkheads or divisions of any kind, facilitates the work of the automatic unloaders. Such an arrangement of cargo space with an open sweep of more than 400 feet is without parallel in the annals of steel ship construction. And, finally, the hatches of vessels of this design have been arranged with direct reference to the requirements of the automatic unloading machines. Each of the new vessels will have thirty-four hatchways (one more than the *Wolvin*) each hatch measuring 33 feet in length by 9 feet wide in the clear, spaced 12 feet centers, which space can be covered by the automatic ore unloaders working without assistance. Incidentally it may be noted that one of the most important of the subordinate improvements is found in the introduction of a system of steel plate sliding hatch covers, operated by steam power, resulting in a great saving of time and labor over the old plan of opening and closing the hatch covers by hand.

The adoption of the arch-hopper type of construction has, of course, entailed a reduction of carrying capacity as compared with what would be afforded by a vessel of equal general dimensions, built according to the former design, but the advantages accruing from the new type more than compensate for any such sacrifice. Undoubtedly one of the most important features of the new type is found in the fact that it makes provision for the use of water ballast to an extent heretofore unheard of in lake freighters. Under the old plan of utilizing for cargo every foot of available space in a hull, which at best had not the depth which its length would suggest to be advisable, the only space for water ballast was in the double bottoms. With the lake type of freighter—a long vessel with all the engines and machinery at the extreme after end—the natural result was that boats running "light," or without cargo, were frequently kept in port, or at least had their progress greatly retarded in heavy weather. The new style cargo carrier, however, with its hopper hold affords, between the perpendicular sides of the hull and the inclined sides of the hopper, ample extra space for water ballast. Each of the four new steamers will have a capacity of 8,500 tons of water ballast, carried at the sides and in the double bottom.

The modern lake cargo carrier is never given very great engine power and the vessels of this new class have machinery of only 2,000 indicated horsepower, which is, however, sufficient to drive them fully loaded at a speed of 11 to 12 miles per hour. That there is considerable difference of opinion as to the best type of machinery to install is attested by the fact that the *Wolvin* has quadruple expansion engines with cylinders 18 1-2, 28 1-2, 43 1-2, and 66 inches in diameter by 42 inches stroke of piston, to which steam is supplied from two water-tube boilers of the Babcock and Wilcox type working at a pressure of 250 pounds per square inch, while each one of the four new steamers will be fitted with triple-expansion engines with cylinders 24 1-2, 39, and 65 inches in diameter by 42 inches stroke supplied with steam from two Scotch boilers working at 170 pounds pressure. However, a *résumé* of the large freighters now building or under contract in lake shipyards shows a preponderance of opinion in favor of the triple-expansion engines and the Scotch boiler provided with induced or forced draft.

Each of the four steamers building for the United States Steel Corporation will have a carrying capacity of 10,000 gross tons on a mean draft of 19 feet, enabling the quartette of four vessels to move 800,000 tons of iron ore in a season of average length,



THE HOPPER BOTTOM OF THE WOLVIN, SHOWING MASSIVE GIRDER FRAMES.

and increasing the aggregate carrying capacity of the entire Steel Corporation fleet to approximately 10,000,000 tons per season. That the new type of lake craft is neither an experiment nor the fad of one firm or individual, is attested by the fact that the opening months of the year 1905 see not less than seven of these 10,000-ton vessels under construction in lake yards for four different firms, while on the stocks at the same time are seven other cargo carriers ranging in length from 500 to 524 feet, and with carrying capacities of from 8,000 to 9,000 tons each. Indeed there is, at this writing, only one bulk freighter under contract on the lakes which is less than 500 feet in length or has a capacity below 8,000 gross tons.

While the new freighters of the 8,000 to 10,000-ton class are, almost without exception, to be constructed on the arch plan, the sides of the hopper holds will, in a few instances, be straight instead of sloping, thus curtailing, of course, the opportunities for carrying water ballast. The equipment of the new carriers shows an advance over former practice fully proportionate to the increase in the size of hulls. One notable innovation is the installation on each boat of two direct-connected electric plants of ample power to light every part of the ship. The illuminating plant is provided in duplicate in order to prevent inconvenience in the event of accident to either plant.

The recent placing of contracts for the new ships appears to mark the rejuvenation of lake shipbuilding, which has been in a somewhat depressed condition for more than a year past. The opening months of 1904 found under contract or construction in all lake yards vessels of an aggregate value of only $3,970,500. The indications are that the opening months of 1905 will find tonnage on the stocks or on the books of the ship builders to an amount fully double that of a corresponding date twelve months previous, and while the aggregate of the opening months of 1903 may scarcely be reached, the proportion of freighters in the whole building programme will probably be larger than in either 1903 or 1904.

The construction of several of these vessels constitutes an important factor in the iron and steel market, and, indeed, in the supply market generally. One of the new 10,000-ton cargo ships weighs 5,500 tons, and 750,000 rivets are used in her construction. In the construction of the four new freighters for the United States Steel Corporation there will be utilized about 14,000 tons of steel plates and small shapes, all of which will, of course, be furnished by the owners. Taking into consideration the needs of all the steel ship building plants on the lakes there is in sight a market for not less than 40,000 tons of shapes and plates.

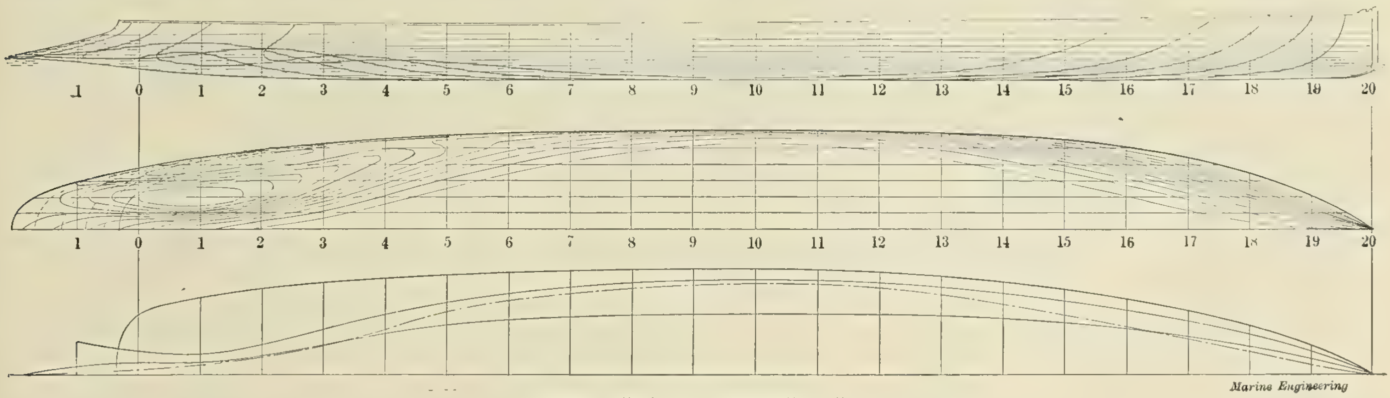
ON THE FORWARD DECK OF THE WOLVIN, SHOWING HATCHES.

The fourteen or more freighters of the new 8,000 to 10,000-ton class will be constructed for the most part by the American Ship Building Company, the consolidation controlling yards at Cleveland and Lorain, Ohio; Wyandotte, Mich.; West Bay City, Mich., and South Chicago, Ill., but contracts for several of the new type of craft are in the hands of the Great Lakes Engineering Works at Detroit, Mich. All the plants which will be engaged upon these contracts are essentially modern in equipment, qualified to handle this class of construction in the most expeditious manner possible, and it is anticipated that there may even be an improvement over the record made in the case of the pioneer 10,000-ton vessel, the *Wolvin,* which was launched in a total elapsed interval of 4 months and 9 days from the time the keel was laid, despite the loss of 20 days during the period by reason of floods and bad weather.

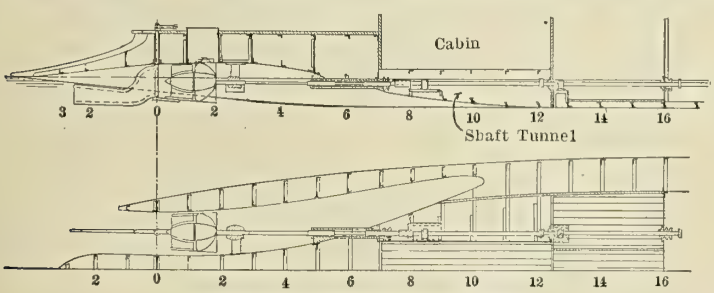
DESIGN OF A SHALLOW-DRAFT BOAT DRIVEN BY TWIN-TURBINE PROPELLERS.*

BY O. LIENAU.

The specification of this boat consists of the following problem: Required a fast boat of shallow draft for the purpose of inspection of a fortification located on a river. The draft of the vessel fully equipped, and provided with sufficient coal for 20 hours' steaming at full speed, shall not exceed 16 inches. The speed in slack water shall be 13 knots. The vessel shall have a cabin, with accommodations for five inspection officers, as well as other conveniences. A small mess room is also to be provided. It is optional to equip the boat with either a single screw or with twin screws, or to drive it with turbine screws. In the latter case it was stipulated that the turbine screws should be easily accessible.


LINES OF THE SHALLOW-DRAFT BOAT.

The choice of propellers determined the construction as well as the lines, and the entire installation. As it is almost impossible to obtain a speed of 13 knots with a single propeller on 15 3-4 inches draft, the twin-screw system was chosen, as with this system the feed of water to the wheels is much more favorable in shallow water than to a single screw located amidships. The turbine screw received the most favorable consideration, owing to the fact that an ordinary screw at 480 revolutions and 75 horsepower would have to be at least 24 inches diameter, of which about 10 inches would project above the water level. Under such a condition the screw would work very inefficiently, and even if it were placed in a carefully constructed propeller tunnel the feed of the water to the screw would be poor. A turbine propeller, however, will work well under such a condition, even if the center of the shaft is almost level with the surface of the water. The objection to the turbine propeller lies mainly in the fact that it is inefficient when going astern, but this objection is compensated for by the advantages quoted, and furthermore is reduced to a minimum owing to the fact that the directing vanes are only slightly inclined to the axis.



LONGITUDINAL SECTIONS AT THE STERN.

After deciding upon the style and design of the propellers, it was necessary to determine the dimensions of the vessels, of which there was made first an approximate, and later an exact, estimate of the weights, as follows:

1. Weight of hull, $L \times B \times H \times 231$ pounds, as a mean value, according to the experience of various firms.

2. Engine and Schultz boiler, 66 pounds per I. H. P.

3. Coal consumption at full speed, 2.1 pounds per I. H. P. per hour.

4. Equipment and crew, 1.5 tons, of which .75 ton represents equipment, and .75 ton corresponds to the weight of the crew of 10 men.

To determine the I. H. P. the French formula I. H. P. $= \frac{V^3\varphi}{m^3}$ was used, and the factor was calculated to be equal to 2.65.

Dimensions of the vessel were calculated to be as follows:

Length between perpendiculars	69 feet 6 inches
Length over all	76 " 9 "
Greatest breadth molded	11 feet 0 inches
Draft of water	15 3-4 inches
Displacement	16.29 tons
Block coefficient	0.565
Midship section coefficient	0.92

$$\frac{L}{B} = 6.33, \qquad \frac{D}{B} = 0.12.$$

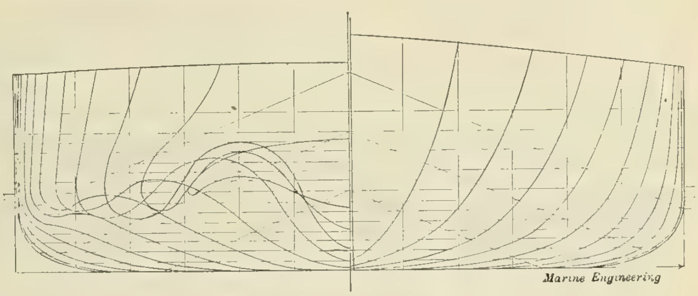
A speed of 13 knots is attained with two engines of a combined I. H. P. of 150, at 480 revolutions per minute.

Diameter of propellers, 23 5-8 inches.

Working pressure of Schultz boiler, 155 pounds per square inch, gauge.

Steaming radius at full speed, 20 hours.

Radius of action, 260 knots.


BODY PLAN OF THE BOAT.

Crew. 1 pilot, 1 engineer, 1 fireman, 1 boy, 5 officers, 1 orderly. Total, 10 men.

Total weights.

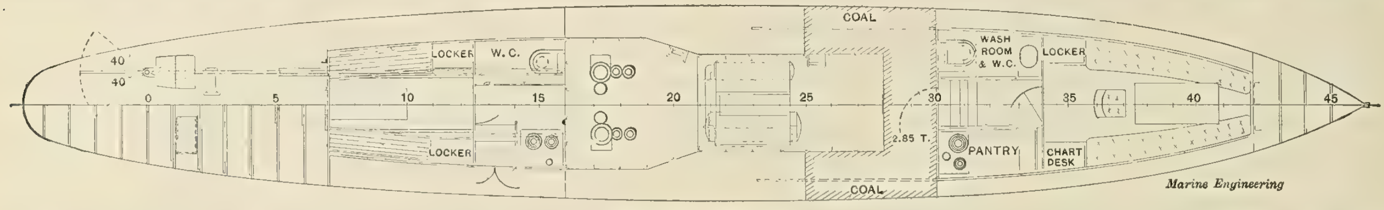
Hull	8.07 tons, or	49.5 percent
Engines and boilers	4.36 " "	26.7 "
Coal	2.88 " "	17.8 "
Equipment and crew	0.98 " "	6.0 "
Total	16.29 " "	100.0 "

In the design of the vessel great attention was paid to the after body, as it was of the greatest importance to allow the water to flow freely to the turbine screws, and also to be properly discharged by these. In order to accomplish this it was decided to

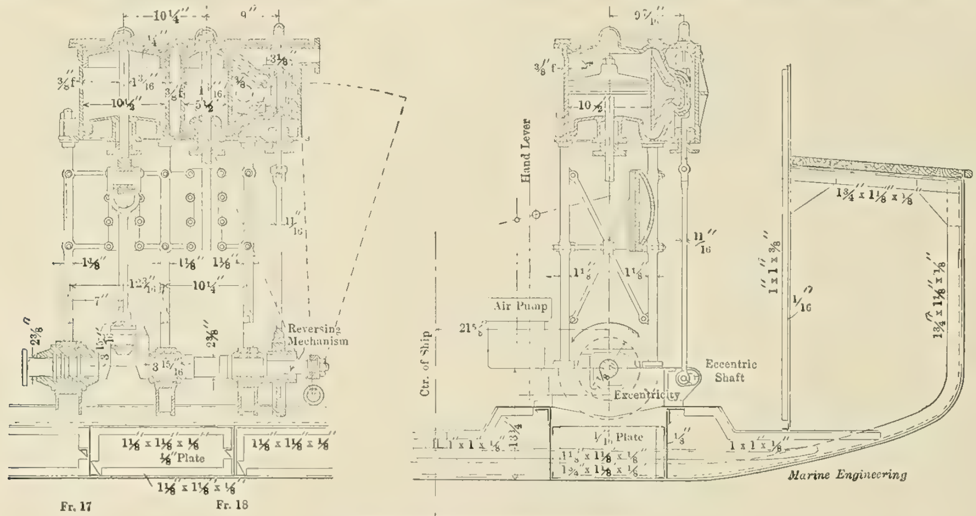
*Translated for MARINE ENGINEERING from *Schiffbau.*

permit the water to flow to the screws from the sides. The stern was given a long projecting shape similar to a duck's tail, which had the advantage that it gradually guided the water into the axial direction of the propellers. As the boat was equipped with two rudders, the keel could gradually grow smaller as it approached the stern, and the shape of the stern protected the rudders when landing. Furthermore, it was designed so that the center of gravity lay well aft, as the greatest weights were placed there. It was therefore located 4 inches forward of amidships. The lines of the forebody were of the customary shape, and arranged to give ample deck room for the cabin.

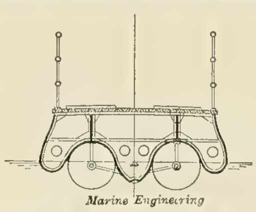
The distribution of weights had to be carefully considered. The officers' cabin was placed well forward, so that it balanced the weight of the machinery aft, and also afforded the inspecting officers an elevated position and an unobstructed view in all directions. The crew's cabin aft was built very light. The boiler was located at the fore-and-aft center of gravity. The forward cabin was fitted with a substantial table for five persons and sofas for accommodating seven persons, and, furthermore, with a large clothes locker and chart desk for fortification charts, and drawers under the sofas. The windows are particularly large in order to afford a broad outlook in bad weather. Aft of this cabin is located a toilet room with wash basin and water closet, and on the opposite side of this a pantry with a small stove and serving table. Sliding doors are fitted to the two last mentioned spaces. The entrance has a booby hatch and single door. On the port side a small ladder leads to the deck above the cabin, which space is fitted with two wooden seats and affords a view in all directions.



ACCOMMODATION PLAN.



ONE OF THE COMPOUND ENGINES.



SECTION AT THE TRANSOM FRAME.

The fire room is surrounded by bunkers, the latter being all located beneath the deck, leaving ample room to fire. The engine space is quite roomy, allowing access to the engines from all sides. Both spaces are accessible by means of a single door and swinging hatch. The steering wheel is located above the boiler room, and a small pilot house, open at the back, protects the pilot from wind and weather. The boiler and engine spaces are separated from each other by a thin bulkhead.

The after cabin is fitted up for the crew of four men. The starboard door leads to a small galley, and a water closet is fitted on the port side, accessible by means of a sliding door. The cabin is fitted with a table, two settees, and two lockers. The engine shafts leading through this space run under the settees and are accessible by means of hinged covers. The two propellers can be withdrawn through two hatches in the deck, each hatch being fitted with light iron covers. Below the hatches are openings in the top of the propeller tunnels, which openings are fitted with watertight covers with rubber gaskets. In order to withdraw a propeller or a shaft, the shaft section under the settees is disconnected and the shaft drawn inboard, releasing the propeller. The guiding end of the shaft at the after end of the propeller can be drawn aft through the hub of the guide wheel.

The material of the hull is the best ship's steel. In order to save weight as much as possible the scantlings were designed similarly to the requirements of the Germanic Lloyd, Class 1, $100 \frac{A}{4}$ for inland vessels; although these sizes were reduced to some extent—not enough, however, to cause the stress to exceed 4,450 pounds per square inch in the outer fiber. The weakest place is the thwartship coal-bunker, which accordingly is braced by means of an angle-iron structure. The after-body had to be strengthened in various places, notably at the shaft bearings and propeller openings. The deck stringer has therefore been spread over the entire after-deck from frame 0 to frame 4, and braced at the middle. The floors were carried over the turbine tunnels. The rudders have a strong bearing, and the rudder heels are attached to the lower part of the guide wheels, which are very stiff, owing to their circular form.

The scantlings are as follows:

Length, 69 feet 6 inches. Breadth, 11 feet 0 inches.

Depth, 3 feet 3 3-8 inches. Draft, 1 foot 3 3-4 inches.

Stem, 3 inches by 25 pounds. Plate keel, 27 1-2 inches by 4 pounds.

Plating, 4 pounds. Sheerstrake, 19 3-4 inches by 4 pounds.

Deck stringer, aft, 19 5-8 inches by 4 pounds.
" " amidships, 37 3-8 inches by 5 pounds.
" " forward, 12 inches by 5 pounds.

Frames, 1 3-4 inches by 1 1-8 inches by 1-8 inch. Reverse frames, 1 1-8 inches by 1 1-8 inches by 1-8 inch.

Floors, at every frame, 3 1-2 inches by 4 pounds. Deck beams, at every frame, 1 3-4 inches by 1 1-8 inches by 1-8 inch.

Beam gussets, 4 pounds. Keel angles, 1 1-8 inches by 1 1-8 inches by 1-8 inch.

Frame spacing, 18 inches. Deck-house, 3 pounds. Deck-house angles, 1 inch by 1 inch by 1-8 inch.

Engine and boiler foundation, 5 pounds. Floor plates, 5 pounds.

Bulkheads, 3 pounds. Bulkhead angles, 1 inch by 1 inch by 1-8 inch.

Wood deck, 1 3-16 inches. Wooden walls of cabins, 3-4 inch.

Rivets, 5-16 inch and 3-8 inch diameter for plates 4 pounds and 5 pounds thick. Rivet spacing for outside plating, 3 1-2 diameters; and for frames, deck-beams, and seams not water-tight, 7 diameters. All is single riveting, with the exception of the cross-seams of the deck-stringers of 5 pounds thickness, where it is chain-riveted with butt-straps, spacing 4 diameters.

Calculations of the turbine screws.

The greatest diameter of the turbine screw which was permissible was 23 5-8 inches; revolutions, 480 per minute; horsepower of each engine, 75; and diameter of shaft, 2 3-8 inches. The following results are therefore obtained:

Area of circle	438.2	square inches
Sectional area of hub	4.4	" "
" " " blades	12.5	" "

This leaves a free sectional area of 421.3 square inches. The effective free sectional area was assumed to be 403 square inches.

Assuming the entrance slip to be 15 percent, the speed of entrance of water would be 25.82 feet per second, and the speed of the boat = 13 knots = 21.95 feet per second.

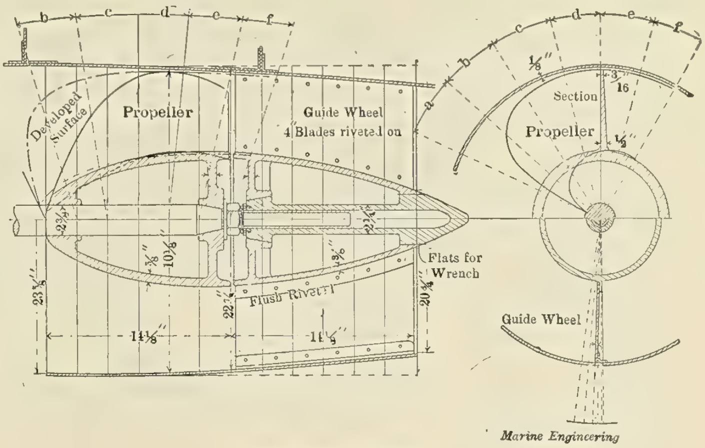
$$\text{Slip} = 15 \text{ percent} = \frac{w - v}{u} \times 100, \text{ and } w = \frac{v}{0.85} = 25.82 \text{ feet}$$

per second.

The speed of discharge was assumed, from previous experience, to have a slip = 45 percent. This therefore gives a speed of discharge of 39.37 feet per second. In the further design of the propeller it was determined that the speed of the water in the screw would increase according to the law of the parabola, and therefore the increasing pitch was designed according to the same law. Furthermore, the cross-section of both the propeller and the guide wheel was also designed according to this law, as such a curve was well adapted to suit the shape of the tunnels. After the beginning and ending points of the parabolas were calculated they were graphically transferred to the drawings of tunnels. The hub sections were calculated by deducting from the total sectional area of the circle the sum of the free sectional area, the area of the cross-sections of the blades, and an allowance for friction and eddy formation.

The guide wheel was designed on the assumption that the rotation slip is 20 percent. The peripheral speed of the water at discharge is therefore:

$$\frac{\pi \times 2\,5\text{-}8 \text{ feet} \times 480}{60} \times 20 \text{ percent} = 13.2 \text{ feet per second.}$$



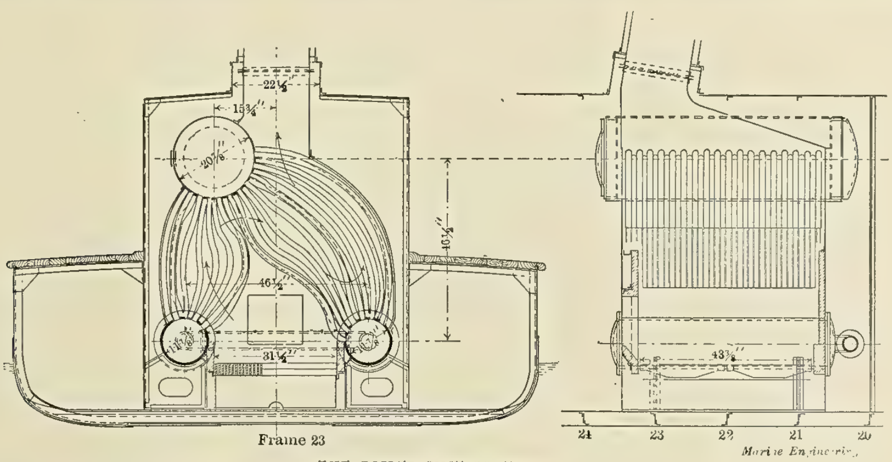
THE TURBINE SCREWS.

The angle of discharge of the water as well as the angle of inlet to the guide wheel were then determined graphically and the latter direction was changed to an axial direction by means of a circular arc.

The propeller is made of bronze, the blades being cast onto the hub and those of the guide wheel being riveted on.

Schultz boiler.

Indicated horsepower per square foot of grate surface = 15.8.
Grate, 43 3-8 inches × 31 1-2 inches = 9 1-2 square feet.
Heating surface, 351 square feet.
Ratio, heating surface to grate area, = 37 to 1.
Boiler tubes, 176, of 1.181 inches outside diameter, 1 inch inside diameter; 192 of 1.417 inches outside diameter, 1.181 inches inside diameter; 368 tubes in all.
Water capacity, 1,100 pounds.
Steam pressure, 155 pounds per square inch.



THE BOILER INSTALLATION.

Area of stack $= \frac{1}{6.5}$ of grate area, = 1.46 square feet.
Two engines. Indicated horsepower, each 75.
High-pressure cylinder, 5 1-2 inches diameter.
Low-pressure cylinder, 10 1-2 inches diameter.
Stroke, 7 7-8 inches.
Pressure in receiver, 47 pounds per square inch.

Revolutions, 480 per minute.

High-pressure cut-off, down, 70 percent; up, 64 percent.

Low-pressure cut-off, down, 69 percent; up, 64 percent.

Angle of advance of eccentric, high-pressure, 40 degrees; low-pressure, 42 degrees.

Diameter of crank-shaft, 2 3-8 inches. Width of crank-slabs, 1 9-16 inches.

Diameter of crank-pin, 2 3-8 inches. Length, 3 1-8 inches.

Length of bearings, 3 15-16 inches.

Truss-block, 4 rings of 3 11-16 inches diameter, 1-2 inch thick.

Piston rod, base of thread, 13-16 inch; full diameter, 1 3-16 inches.

Connecting rod, diameter at top, 1 3-16 inches; at bottom, 1 7-16 inches.

Connecting rod, length = 5 cranks = 19 5-8 inches.

Piston thickness at hub, high-pressure = 1-4 inch; low-pressure = 3-8 inch.

Piston thickness at edge, high-pressure = 1-4 inch; low-pressure = 5-16 inch.

Three Ramsbottom Rings in piston 5-16 inch wide and 5-16 inch deep.

Cylinder walls, thickness 3-8 inch.

" flanges, depth 9-16 inch; width 3 1-8 inches.

Bronze cylinder covers, thickness 1-4 inch.

Number of studs in same, high-pressure 8; low-pressure 12.

The engines are compound with jet condenser. At the forward end of the high-pressure cylinder an eccentric is located which drives the high-pressure valve, and from this eccentric, by means of a combination of levers at the side, the low-pressure trick slide valve is also driven. Reversing the engine is effected by an arrangement located inside of the eccentric. The air pumps are driven by the low-pressure cross-heads, and are placed between the two engines in order to make them more accessible.

The stability calculations of the hull were made according to the method of McFarlane-Gray-Fellow. The stability quickly increases to 45 degrees, and then decreases quickly and reaches 0 at an angle of 67 degrees. This is caused by the fact that the side overhang of the boat acts as a pontoon and causes the stability to rise quickly at first, but as soon as these parts are submerged the increase is slight.

POWERING SHIPS.

BY EDWIN CERIO, NAVAL ARCHITECT.

PART IV.

VI. POWERING SHIPS BY MEANS OF MODEL EXPERIMENTS—EXPERIMENTAL TANKS.

As already said, if the total resistance of a ship's model is experimentally determined, by subtracting the part due to friction and multiplying the residual resistance by the cube of the ratio of similitude between ship and model, the *residual* resistance of the ship may be found; to this it is necessary to add the skin-resistance of the vessel in full size, thus obtaining the total resistance, from which it is easy to obtain the E. H. P., and, finally, the I. H. P. This is the method originally recurred to by Froude in the classical experiments carried out with the *Greyhound*.* This vessel was towed by the *Active*, and the force developed by the traction was measured by a dynamometer at every run. Similar experiments were repeated on a model of the *Greyhound*, and the method described above was adopted to find the ship's resistance from that of the model. Having plotted out on a diagram the results obtained in both cases, the two curves representing the law of variation of resistance at different speeds practically coincided.

Model experiments are now carried out in experimental tanks. A laboratory in which very important investigations on ships' resistance have been made is that of Spezia, Italy. It was founded in 1887, and comprehends two distinct parts: that in which the paraffine models are prepared, and that in which they are tested. For the preparation of the models all the necessary contrivances are provided, such as the model-forming machine, a foundry, and a complete set of tools and machinery. The casting-box has the following dimensions: length 29 1-2 feet, breadth 4 1-3 feet, depth 2 feet 3 3-16 inches. The experimental tank, a transverse section of which is given in Fig. 10, is 480 feet in length. The North German Lloyd, after very satisfactory results obtained by placing models of its ships under experiment in Italy, decided to erect an experimental laboratory of its own; this was in 1899, and the experimental tank, which was the first in Germany, is in Bremerhaven. The laboratory covers an area of about 34,000 square feet, 22,000 of which are protected by sheds and roofs. A remarkable difference between this tank and nearly all others, is that it is constructed entirely of wood. Its dimensions are 540 feet in length, breadth 19 feet 8 1-4 inches, depth 12 feet 1 11-16 inches.

The preparation of the models is subject to special care; the paraffine, from which the castings are obtained, is melted in copper crucibles in which a tube is fixed, containing steam at a pressure of 10 pounds per square inch. As it is important not to heat the paraffine at too high a temperature, some experimenters prefer to melt it in a crucible surrounded by warm water (Bain-Marie); the best castings are obtained with paraffine heated at about 150 degrees Fahrenheit. The paraffine must also be purified before it reaches the casting-box; it is therefore made to riddle through a sieve of brass wire-gauze. The cast model is then put under the model-forming machine and shaved until it reproduces exactly, at a given scale, the form of the ship, and then it is ready for experiment.

TABLE XVIII.

Ratio of similitude between ship and model.. ρ	Ship.	Model.
Corresponding speeds	V	v
Displacement	D	d
Length	L	l
Wetted surface	S	s
Resistance due to skin friction	R_f	r_f
Resistance " " wave configuration	R_w	r_w
Resistance total	R	r
Constants	$C_t = \frac{R}{D}$	$C = \frac{r}{d}$
	$F_s = \frac{R_f}{D}$	$F_m = \frac{r_f}{d}$
	$C_w = \frac{R_w}{D}$	$C_w = \frac{r_w}{d}$
	$K = \frac{V}{D^{\frac{1}{6}}}$	$K = \frac{v}{d^{\frac{1}{6}}}$
	$M_c = \frac{L}{D^{\frac{1}{3}}}$	$M_c = \frac{l}{d^{\frac{1}{3}}}$
	$S_c = \frac{S}{D^{\frac{2}{3}}}$	$S_c = \frac{s}{d^{\frac{2}{3}}}$

MODEL EXPERIMENTS.

The method originally introduced by Froude is no longer used when testing models. The *method of constants* has taken its place, and will here be described.

Applying the law of dynamical similitude to the motion of ships it is possible to determine two functions, of resistance and speed, which depend only upon the speed of the ship and her shape, but are not influenced by her size. Thus, once the resistance of a ship's model is found by determining these constants, the results are applicable to any vessel which bears geometrical similarity to the model, provided the law of dynamical similitude is satisfied. To facilitate reference to the symbols employed hereafter,

*The *Greyhound* was an old corvette of the following characteristics: Length, 173 feet; breadth, 33 feet; draft, 13 1-2 feet; midship section area, 338 square feet; wetted surface, 7,540 square feet; displacement, 1,160 tons. Similar investigations to those of Froude had already been carried out in France, between the years 1840 and 1866, by Dupuy de Lôme and Bourgeois, with the ships *Sphinx, Pingouin, Duperré, Heroïne, etc.*

all the characteristics of ship and model, as well as the constants used, are gathered in Table XVIII; the meaning of these constants is explained in each case in which they occur.

Owing to the similarity of ship and model, and having assumed the speeds V and v as *corresponding speeds,* the following equations may be written:

$$\frac{D}{d} = \frac{R_w}{r_w} = \rho^3 \text{.............................} (1)$$

$$\frac{V}{v} = \sqrt{\rho} = \rho^{\frac{1}{2}} = \frac{D^{\frac{1}{6}}}{d^{\frac{1}{6}}} \text{.......................} (2)$$

therefore

$$\frac{R_w}{D} = \frac{r_w}{d} = \text{constant} = C_w \text{..................} (3)$$

and

$$\frac{V}{D^{\frac{1}{6}}} = \frac{v}{d^{\frac{1}{6}}} = \text{constant} = K \text{.....................} (4)$$

But

$$R_w = R - R_f,$$
$$r_w = r - r_f,$$

so that the equation (3) may be written:

$$\frac{R - R_f}{D} = \frac{r - r_f}{d},$$

or

$$\frac{R}{D} = \frac{r}{d} - \frac{r_f}{d} + \frac{R_f}{D} \text{.......................} (5)$$

introducing the constants assumed:

$$C_t = C - F_m + F_s,$$

and

$$C - F_m = C_t - F_s = \frac{R}{D} - \frac{R_f}{D} = \frac{R_w}{D} = C_w \text{........} (6)$$

C and K are respectively the resistance and the speed constants, both independent of the ship's size; if a curve is plotted giving the values of K for every corresponding value of C_w, the resulting diagram expresses the law of variation of resistance in relation to speed for all vessels similar to the model. The constant, which applies only to that part of the resistance due to wave configuration, must be transformed into a constant C_t containing reference also to total resistance. The resistance due to friction may be expressed by the formulæ:

$$R_f = f_s S V^{1.825} \text{ and } r_f = f_m s v^{1.825}.$$

consequently

$$F_s = \frac{1}{D} f_s S V^{1.825} \text{..........................} (7)$$

and

$$F_m = \frac{1}{d} f_m s v^{1.825} \text{..........................} (8)$$

Having assumed $M_c = \frac{L}{D^{\frac{1}{3}}}$, the displacement $D = M_c^{-3}.L^3$..(9)

" " $M_c = \frac{l}{d^{\frac{1}{3}}}$, " " $d = M_c^{-3}.l^3$..(10)

" " $S_c = \frac{S}{D^{\frac{2}{3}}}$ the wetted surface $S = S_c.D^{\frac{2}{3}}$....(11)

" " $S_c = \frac{s}{d^{\frac{2}{3}}}$, " " " $s = S_c.d^{\frac{2}{3}}$....(12)

The relation between the corresponding speeds may be written:

$$V = v\sqrt{\rho} \text{ or, as } \sqrt{\rho} = \frac{D^{\frac{1}{6}}}{d^{\frac{1}{6}}},$$

$$V = \frac{v}{d^{\frac{1}{6}}}.D^{\frac{1}{6}} = K D^{\frac{1}{6}} \text{......................} (13)$$

In the same way it may be found that:

$$v = K d^{\frac{1}{6}} \text{..............................} (14)$$

Substituting the values given by the equations (9), (10), (11), (12), (13), and (14), in the equations (7) and (8):

$$F_s = f_s.D^{-1}.S_c.D^{\frac{2}{3}}.K^{1.825}.D^{\frac{1.825}{6}} = f_s.D^{-\frac{0.175}{6}}.S_c.K^{1.825},$$
$$= f_s.M_c^{\frac{0.175}{2}}.L^{-\frac{0.175}{2}}.S_c.K^{1.825} = f_s M_c^{0.0875}.L^{-0.0875}.S_c.K^{1.825}$$

the product $f_s.L^{-0.0875}$ may be considered as a coefficient depending upon the ship's length, and called O_s. Then:

$$F_s = O_s.M_c^{0.0875}.S_c.K^{1.825} \text{...............} (15)$$

In the same way it may be found that:

$$F_m = O_m.M_c^{0.0875}.S_c.K^{1.825} \text{..............} (16)$$

where $O_m = f_m.L^{-0.0875}$

By means of these equations it is possible to express the total resistance, the wave- and skin-resistance, with known quantities and experimental factors as follows:

$R_f = F_s.D.$

$R_w = C_w.D = (C - F_m)\ D.$ (See equation 6.)

$R = C_t.D = (C_w + F_s)\ D.$ (" " 6.)

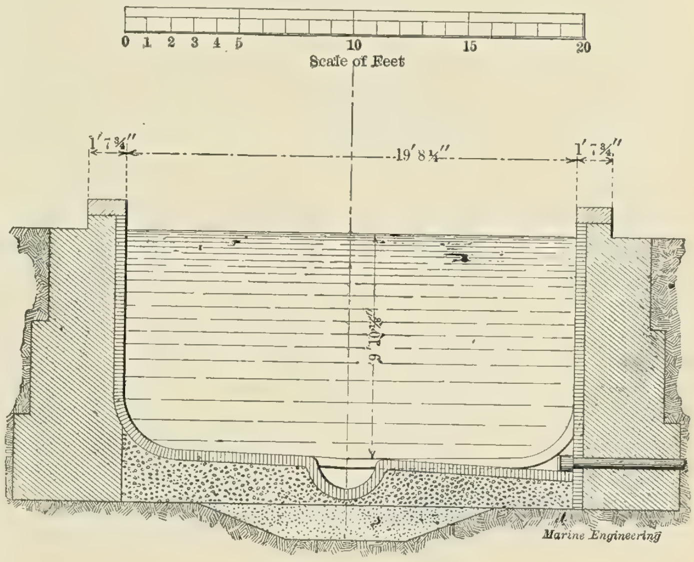
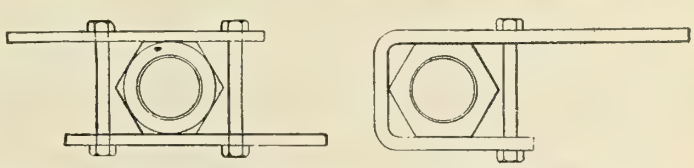


FIG. 10.

Therefore, when the resistance of a ship has to be determined with model experiments, the part due to wave configuration is obtained very simply by multiplying the quantity C_w by the displacement; that due to friction is found first by reading the value which has to be assumed for the product $f_s.L^{-0.0875} = O_s$ in a table where such values are calculated for all lengths of ships; then by multiplying this coefficient by the quantity $M_c^{0.0875}.S_c.K^{1.825}$, and by the displacement.

It is understood that the speeds must satisfy the condition established by equation (13). This method proves very practical whenever a tank can be disposed of; should the model be tested in fresh water the necessary correction must be made, and care must be given to the choice of appropriate units to measure the different elements which enter in the formulæ given.

Making Large Wrenches in Emergencies.—For turning nuts on large unions where there is no wrench of a size suitable for the work in hand, it is not always necessary to forge a wrench. For a brass union on a 2 1-2-inch pipe, take two pieces of iron about 1-2 inch by 2 1-2 inches and 18 inches long and two 1-2-inch bolts.



Bore holes for the bolts and screw up as shown at Fig. 1. The two projecting ends coming on opposite sides will serve as handles for turning. Friction is reduced by applying force on two sides of the pipe. Where there is not room enough to use this wrench, heat a single piece of iron, bend it into the shape of Fig. 2 and join with one bolt. Turn by means of the long handle.—*The Fulcrum.*

MAINTENANCE OF MACHINERY IN MERCHANT SHIPS.*

BY ROBERT HAIG.

The maintenance of machinery in merchant ships is a problem that is steadily becoming of higher importance by reason of the increase in size and power, the greater complexity and detail now found on board high-class vessels, and also because of the greater demands now made for a higher efficiency in the machinery, and the personnel of the engineering staffs afloat and ashore. The present-day ships call for engineers of wide experience, men of good education, who have had a thorough practical training for their business, combined with sufficient theory to enable them to appreciate heat losses, combustion, feed heating, electrical and refrigerating installations, and the many other duties that go to make up the experienced engineer, in whose hands in conjunction with the shore engineer superintendent the maintenance of valuable shipping property is entrusted. In dealing with this subject there will also be considered the various changes, improvements and developments that experience gained in maintenance has brought about.

Engine Foundations.—The practice now usually followed where a vessel is fitted with a double bottom is to put the engines right down on the tank-top, the scantlings of the inner bottom having been made heavier for that purpose. Formerly it was the practice to build a seating of deep girders and intercostals securely riveted and bracketed to the tank-top plating and the framing underneath. This made a very satisfactory foundation when well built, and it had the further advantage that the heads of the holding-down bolts could always be got at. The ruling practice at present, however, is to put the engines down on the tank-top plating, and it is here very serious trouble is met with by holding-down bolts breaking and becoming loose, by engines working on the seatings and causing serious trouble, and this will always ensue unless the highest quality of workmanship is put into the double bottom in the machinery space.

It is not suggested that placing the engines down on the tank-top is an inferior arrangement to the built-up seating; it is inferior only when adequate provision has not been made for strengthening the tank-top and double bottom at this part.

As is well known the scantlings of the double bottom in the machinery spaces are considerably increased, double reverse frame bars are fitted, and altogether the double bottom at this part is, or should be, of superior construction to what is required at other parts of the vessel. It is but rarely, however, that the material fails; the usual trouble is from bad workmanship, such as unfair holes and bad riveting produce, and that in a place where nothing but the best possible workmanship will stand. The intercostals should be well fitted; the rivet holes should be absolutely fair; the countersinking of the holes in the tank-top plating should be almost, if not the whole, depth of the plating, and the rivets laid up with good full points, so as to ensure a thoroughly strong connection. When we consider what a pull must come on this work when the engines are swinging about, it will be seen how very necessary it is that the holding-down bolts should take hold of a good foundation.

Care should be taken in spacing the holding-down bolts that they go straight down, not at an angle (Fig. 1); also that they do not come down on the heel of the frame bars, as in that case they have to be tapped into the top plating without being reinforced with a nut underneath, and it is these unfair bolts that are most frequently broken in working; and, unfortunately, broken and loose holding-down bolts are altogether too common. As so much of the successful working of the engines depends upon the design and workmanship of the engine seating and fastenings, the vital importance of this point cannot be too highly rated, nor the demand for good workmanship too rigidly enforced.

Shafting.—Although last winter was one of the most severe of recent years, the number of broken crank shafts was comparatively few when compared with the failures of past years, and this is not surprising and can readily be explained by the higher quality of material of which shafts are now made, by the increased attention given to the bearings and keeping the shafts in alignment, and also, no doubt, to the improved design and construction of the engine bed-plate foundations.

Although for very sufficient reasons solid crank shafts are still used in war ships, they are in merchant ships a thing of the past, and we have instead built crank shafts of nickel and carbon steels of the highest quality, well designed and constructed, with the result that broken crank shafts are exceedingly rare.

In the early days of built shafts no doubt there were many failures, and loose crank pins and unfair shafts were common, but higher quality of material, greater experience and accuracy in machining, improved methods and knowledge of shrinking the various members together, have resulted in producing shafts as nearly mechanically perfect as could be desired.

Built shafts are heavier, but that is of little importance in merchant ships, when compared with the higher quality of shaft, lower cost of manufacture, and also the very much reduced time required to renew.

Propeller shaft troubles have been numerous and their maintenance comes very high, by reason of the delay caused by repairs, cost of docking, etc. If we had only the torsional stresses set up by the power transmitted from the engines to deal with, this could be readily met by increasing the size of the shaft until the

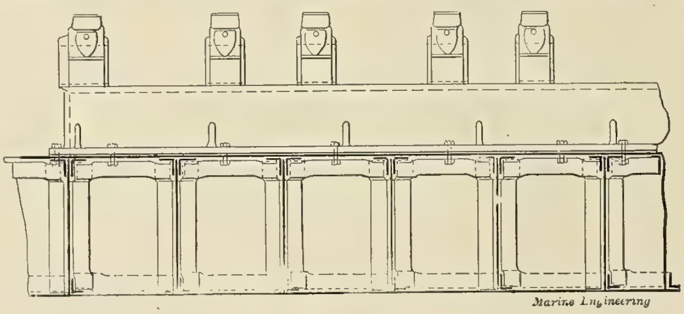


FIG. 1.

weakness was overcome; but a brief analysis will show that the stresses borne by the propeller shafts are of a widely varying nature. We have the stresses set up by the overhung weight of the propeller, which in some cases reaches 25 tons; also the bending stresses due to the change of the center of effort brought about by the continuous variation in the immersion of the propeller, and which reaches its maximum when a vessel is pitching heavily or in a more or less light condition; and, further, the abnormal stresses developed by the rapid acceleration and as sudden retardation of the momentum of the propeller when the engines are racing, all combine to produce conditions that demand a very high degree of efficiency both in the material and workmanship of the propeller shaft and stern bearings. There is the further troublesome factor to be considered, namely, the wastage on the propeller shaft at the ends of the brass sleeves due to the so-called galvanic action or fatigue; but happily this latter feature of the trouble has been to a large extent eliminated of late by protecting the shaft with brass sleeves for its entire length, thus doing away with what has hitherto been a serious menace to the life of propeller shafts.

In some cases the brass sleeves are put on in one length, which course is much to be desired, but where the shafts are long and the sleeves require to be built up of several lengths the greatest care should be observed to have the joints of the sleeves perfectly water-tight, as leakage at these parts causes scoring, and the shaft may rapidly become unsound without giving any outward evidence of the fact.

Considerable success has been attained by running propeller shafts without any brass sleeves whatever; the stern tube being

*Paper read at the twelfth annual meeting of the Society of Naval Architects and Marine Engineers, New York, November, 1904.

sealed at the outer end by a patented arrangement, which allows for the stern tube being filled with oil.

White metal is fitted into the stern bush instead of the ordinary lignum-vitæ, and the stern tube being filled with oil this makes an oil bath for the shafts and bearing and reduces wear and tear to a minimum.

Under these conditions the S. S. *Clematis* was in commission for five years and nine months, in which time the vessel steamed a distance of 156,000 miles, and when the shaft was drawn for examination the wear on the stern bearing was found not to exceed 1-16 of an inch and on the shaft it was practically *nil,* with the surface of the shaft preserved clean and bright and free from any wastage.

The arrangement of running shafts without any brass sleeves also allows for a shaft of larger diameter being used without increasing the size of the stern tube.

Greater attention is now given to the stern bearings of ships by increasing the length of the bearing, and also by keeping the shafts better in line.

In some long ships of high power flexible couplings have been fitted in the line shafting, generally one at either end, to relieve the stresses due to bending or other movement of the ship's structure.

These couplings have not been very widely adopted as many engineers fail to see the utility of them, and unless of the very best make their bearing surfaces wear rapidly and by their looseness cause considerable noise and jar when the engines are running at unequal speeds.

There is no doubt that these couplings allow the shafting to accommodate itself to any movement that may take place, in a way that could not be obtained if the couplings were held rigidly together as in the ordinary practice, but judging from the comparatively small number of ships that are fitted with flexible couplings, it would seem there was no great need for them, and probably the fault they are supposed to remedy could be reached in some less expensive manner, as the first cost of these couplings is considerable, although their maintenance is not by any means great.

Condenser.—The condenser seems to be the part of the machine that has changed least with the evolution of the present-day marine engine. The principal change has been that the condenser has been detached from the main structure of the engines and is now in many cases being carried higher up on a built-up seating, which arrangement allows for better drainage to the air pumps, easier leads for inlet and discharge piping, and also gives greater access for overhauling the main engines.

Surface condensers, which are really now the only condensers we may consider in marine work, have serious troubles from leaking and faulty tubes. Steamship owners and other authorities have spent considerable time and money in experimenting with the various kinds of tubes, but so far the results have been neither very encouraging nor satisfactory.

The trouble usually found is that after a short time in use, the insides of the tubes are found to be eaten away in spots, and pinholed, as if some active erosive action had been taking place and had attacked certain parts of the material, which is evidence enough to some minds that the tubes are not altogether homogeneous. The various methods of packing condenser tubes have undergone little change, the screwed-in gland being what is now most commonly used, but the materials used in packing the tube ends have changed frequently and have given considerable trouble.

Rubber rings, fiber rings, waxed cotton lacing, and lacing soaked in linseed oil have all been tried in turn, but experience has shown that lacing soaked in oil and properly packed in place makes the most satisfactory job and lasts well under the various changes of temperature. Wooden ferrules soaked in oil and driven into the tube plate makes a much cheaper method of packing a condenser, but has this disadvantage, that if the vessel should be laid up and the condenser remain dry for a length of time the ferrules shrink and split, and before the condenser can be made tight the ferrules require to be renewed. The packing of condensers is generally supposed to be a simple operation, not requiring any great skill or experience, but the results of hurried and imperfectly packed condensers are frequent sources of delay and trouble with feed water when at sea, and I am strongly of opinion that the greatest care and attention should be given to the operation of packing, and when the condenser is filled for testing, it should be with warm water of a temperature not less than 200 degrees Fahrenheit. Although the packing of condensers properly is of the greatest importance, the burden of the condenser trouble is without a doubt in the material of the tubes, in their inability to withstand the deterioration, which is admittedly serious, and more so now than in the past in view of the early probability of a more general use of water-tube boilers, as in that case the necessity of a pure feed water is beyond question.

Various reasons have been advanced to account for condenser troubles, the most prominent theory being the leakage of electric current from the electric generating plant on board, or the galvanic action set up by other conditions existing on board the vessel.

A further reason given is the bad quality of the stream of water sent through the tubes when the vessel is docking, or proceeding up or down a river. Dealing with the last reason first, close observation of the conditions that exist when a vessel is docking will show that great quantities of globules rise to the surface of the water, giving off sulphuretted hydrogen and other gases, the liberation of these gases being caused by the churning of the water due to the propeller working ahead and astern.

Granted the observed conditions of the water in docking, it is reasonable to suppose that even worse conditions may easily prevail in the condenser. Tracing the path of the water upon entering the ship, it is split up into fine streams in passing through the sieve-like grating on the ship's side, coming together again in the inlet pipe, then being broken up again by the action of the fan of the centrifugal pump and finally being split up again into small streams in passing through the tubes. Starting with the assumption that the water in which the vessel is lying is contaminated with sewerage and other foul matter usually found in river water near large cities, this breaking up of the water on its passage to and through the condenser in an increasingly heated state is bound to produce conditions inimicable to the life of the tubes, the worst feature being that, when the circulating pump is brought to rest, this foul and active matter remains in the tubes until the vessel leaves port, during which time I am firmly convinced most of the mischief occurs. If some simple means were adopted for washing out and draining the condenser as soon as practicable after the vessel is docked, it would amply repay for the trouble taken.

The claim that electric leakage is a cause of the deterioration in condenser tubes is one that has given rise to widely different opinions ("Corrosion of Condenser Tubes,") Trans. I. N. A., vol. xliv.) for the reason that the trouble has been quite as acute in ships without any electric generating plant, nor does it seem to make any appreciable difference whether the vessel is wired on the single or double-wired system. While able reasons have been advanced in support of the theory that the return currents in the single-wired system, or stray currents from defective insulation and connections in the double-wired systems, should be accepted as the cause of deterioration in condenser tubes. it is at present difficult to take this as being the only cause; there does not seem any reason why the electric current should single out the tubes for attack when there are other metals of almost the same compositions exposed to the same conditions and yet do not suffer to anything like the same extent.

Condenser-tube plates sometimes show a slight scoring or corrosion in more or less vertical lines, but that is always on the steam side and seldom amounts to anything. and is generally attributed to the acids set free from the grease brought in with the exhaust steam. The composition of the material of the tubes seems to have little bearing on the subject, as they nearly all seem to suffer alike. Of course it is recognized that, although an electric current of itself may not attack the tubes, the effect of an electrical current passing through certain liquids is to split them up and set free corrosive elements from what may otherwise be a comparatively harmless liquid.

If we consider the conditions of the water in the engine room and stoke-hold bilges, which is a solution of fatty acids, fresh water, salt water, drainage from hot ashes and all other sources, and in which the various metals are brought in contact, it is reasonable to expect some galvanic action to take place on the fittings so exposed, and such has been found to be the case to quite a considerable extent in some instances. In some ships corrosion in copper and other pipes in the bilges has been traced to the use of certain animal or vegetable oils, but up to the present little definite progress has been made in determining the cause of the trouble in condensers (Trans. I. N. A., vol. xlv., "Corrosion in Metal Pipes"), and although further investigation may disclose causes not yet ascertained, the theory of electric leakage from the generating current cannot of itself at present be accepted as the only cause of condenser trouble, but it is conceivable that, with a

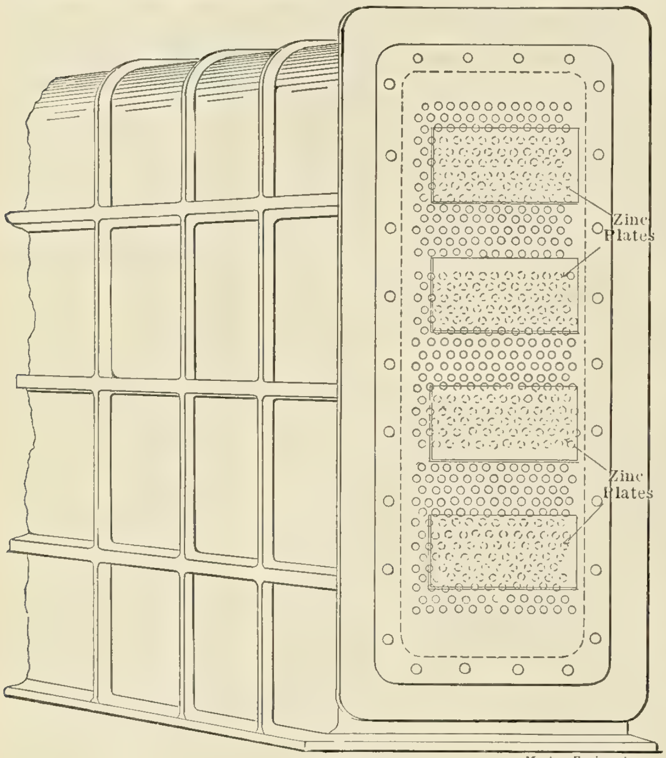


FIG. 2.

condenser having water lying in it highly charged with decomposed matter, conditions could be produced from a combination of causes resulting in action on the material of the tubes. Whether electric leakage is the cause or only a contributory cause, the fact remains that condenser troubles have become increasingly frequent since electricity came into more general use on board ships.

If it can be established that condenser troubles are due to electric current, generated from any source whatever outside of the condenser, it does not appear that it would be an impossible task to insulate the condenser in some manner and so protect it from such attacks. The use of oil in cylinder lubrication that may be carried into the condenser with the exhaust steam has little connection with the question, as mineral oils are now almost exclusively used, and further, the defect is most always found to proceed from the interior of the tubes. The working conditions of condensers have not changed proportionately with the shortened life of the tubes, and it is contended that if one part of the tube remains good, there is every reason to expect the whole tube to remain uniformly good if the process of manufacture is all that could be desired. Homogeneity is a word much believed in by metallurgists and engineers, but, after all, it is only a comparative term and has wide definitions. It is admitted in the very fullest sense that the tube makers have given this matter very considerable attention, and it is hoped they will continue to do so, as there is still something to be done in the way of producing a tube that will come up to the requirements and so rid shipowners of what has been a source of vexation and delay, and also a costly item of maintenance.

Numerous devices have been adopted to counteract the deterioration in the tubes, and the most successful has been to line the water ends of the condensers with rolled zinc plates on studs fitted in the tube plates (Fig. 2). This has been found to improve conditions quite considerably, but is not by any means a panacea for the ills that condensers are heirs to and which will be arrived at only by continued and persistent effort.

Boilers.—In dealing with the present high pressure Scotch boiler, it will be generally agreed that it has now reached its limit in size, thickness of plating and pressure, and although a few boilers of reduced diameter have been built for pressures up to 267 pounds per square inch, the pressure that is found in most general use in our latest boats ranges from 200 to 215 pounds per square inch. The maintenance of boilers with the higher pressures now in use has not materially altered from the conditions existing when lower pressures were dealt with, so long as the conditions of combustion are the same, or, in other words, with natural draught; but as a large proportion of ships are now fitted with assisted draught of one type or another, it is considered desirable to discuss the maintenance of boilers under forced draught conditions. Experience has undoubtedly shown that the working conditions of boilers under forced draught can be made radically different from the conditions which exist under natural draught. The question of forced draught will be dealt with later on; at present it is proposed to discuss only the effects on the boilers. In natural draught we have the temperatures in the combustion chambers due to energetic working of the fires and the draught produced by the funnel, which at no time becomes so excessive as to cause damage to the chamber plates, unless the boilers are allowed to become very dirty from scale on the water side.

With forced draught we have temperatures in the furnaces and chambers of much greater intensity, and which are limited only by the amount of coal capable of being burned on the fire grate and the air pressure obtained in the ash pits, with the result that the combustion chamber plating becomes locally overheated and buckling takes place; stay nuts are burned off, tube ends leak, and the plating cracks through the landing edges of the rivet holes, and this is especially severe in places where any broad landings or doublings are exposed to the flames. Various means have been adopted to protect the surfaces at the back ends, mostly affected by the flame, by fitting tiles made of fire clay or other refractory material and molded to the shape required, but their usefulness is sometimes of short duration, owing to the difficulty of keeping them in place, as the means taken to secure them are rapidly burned off. The most serious trouble met with is in the corners of the furnace plating, where it is flanged up to take the back tube plate, and here, unless the radius of the flanging of the tube plate has been of an easy nature, cracking very soon develops, and as this takes place through a riveted connection, to repair which a three-ply thickness of material will be necessary in places, and which it is found is an impossibility to keep tight in boilers under forced draught conditions. It is true this weakness has been somewhat modified by the adoption of the furnace with the "Gourlay" neck (Fig. 3), but even with this improvement the difficulty experienced in keeping this joint tight is quite acute, as the riveting and calking requires frequent renewal, and each time it becomes more serious than before, by reason of the deterioration of the material causing cracking through the rivet holes and landings.

That this weakness is a common experience can be abundantly proven. Where a boiler is subjected to a high air pressure for a length of time the invariable result is distortion, cracking, and leakage.

The radius of the flanging at the sides of the tube plates to which the furnace back end is riveted should be sufficiently great to allow the plating to be properly laid up and a good riveted connection made without resorting to the use of tap bolts and other such makeshifts.

The other most frequent weakness is shown in the riveting of the furnace to the back tube plate, right over the furnace crown. (Fig. 4.)

This joint is in many cases double riveted, and with two thicknesses of material of a breadth sufficient for a double-riveted joint exposed to the hottest part of the flame, it is found extremely difficult to keep it tight, as the part of the plating exposed becomes overheated and weakened and the movement resulting from this overheating gives rise to extensive leakage. A single-riveted joint has been found to stand perfectly well at this part, and there is no good reason why it should not do so if the spacing of the riveting is properly designed and the work is of the best. It is at this part that protection as previously referred to by fire-brick blocks is urgently required, and when the voyage is short and the blocks can be frequently renewed, they are an undoubted benefit.

In the S. S. *Finland* the builders had the whole of the combustion chambers of one boiler welded throughout, the only riveting being the attachment of the furnace to the back-tube plates.

This was found to be a highly satisfactory job and has not, I understand, given any trouble whatever, the increased cost, I think, being the only objectionable feature.

In the case of the nuts of staybolts being burned off, this has been met by doing away with the nuts on the stay ends that come in a direct line with the furnace, and reverting back to the old practice of riveting the stay ends over, which has been found to answer very well. As the maintenance of boilers has become a serious consideration, it cannot be too strongly pointed out that experience and common sense are just as essential in designing a boiler as it is to get the maximum amount of heating surface into the minimum size of shell. Many boilers are so designed that they are crowded, too closely pitched stays in the steam space, tubes brought close out to the wings and down on the top of the furnaces, with a result that the boiler cannot be either properly cleaned or examined, circulation is retarded, priming is common, and altogether the working conditions of the boiler are unsatisfactory; and further, where such conditions exist, corrosion is always active.

If we consider the various elements that go to make up the ordinary cylindrical or Scotch boiler, it will be recognized that we have a mass of unequal stresses to be taken care of, each stress tending to a movement in the structure and each movement meaning so much fatigue to the material, which in time culminates in leakage and possibly rupture.

The evidences of distortion most commonly met with are:

(1) Cracking set up in the flanging of the back tube plate and furnace connections at this part.

(2) Cracking in the furnaces at the line of fire bars in a longitudinal direction.

(3) Cracking on the knuckle of the flanging of the lower front heads, and also in the case of double-ended boilers the tendency to rupture of the plating through the line of rivets in the circumferential seams at the bottom of the boiler.

(1) This is caused by the unequal expansion of the furnace and the tube plate, due to the upper half of the furnace being so much hotter than the lower half, and also to the impact of the flame on the tube plate joint where there are two thicknesses of material which does not allow of the heat being quickly absorbed by the water.

It is fair to assume that in the case of the back tube plate, perforated with holes and unequally held as it is, there is considerable distortion, as is shown by the leaky tube ends and riveted connections, and also not infrequently by cracked tube plates.

This movement, however, may not be altogether due to the change of form in the tube plate alone, but is doubtless assisted by the action of the furnaces under the varying temperatures to which they are continually subjected, but that the movement is positive and actual has been demonstrated beyond a doubt, both under working conditions and by careful experiment. Mr. Yarrow conducted a series of experiments in 1891 (Trans. I. N. A., vol. xxxii., p. 98), and showed conclusively that with every change in temperature the conditions of the tube plate and connections changed proportionately. At a later date, Mr. Milton, Chief Engineer Surveyor to Lloyd's Register, submitted the results of a considerable number of tests (Trans. I. N. A., vol. xxxiv., p. 157), made by hydrostatic pressure on the various types of marine boilers, and in every case movement of the boiler took place when under pressure.

A case occurred quite recently, with one of the most eminent and best equipped builders in this country, when the question arose as to whether any vertical movement of the combustion chambers took place when under pressure, it being contended that if no movement took place, it would not be necessary to stay the chamber bottoms to the shell.

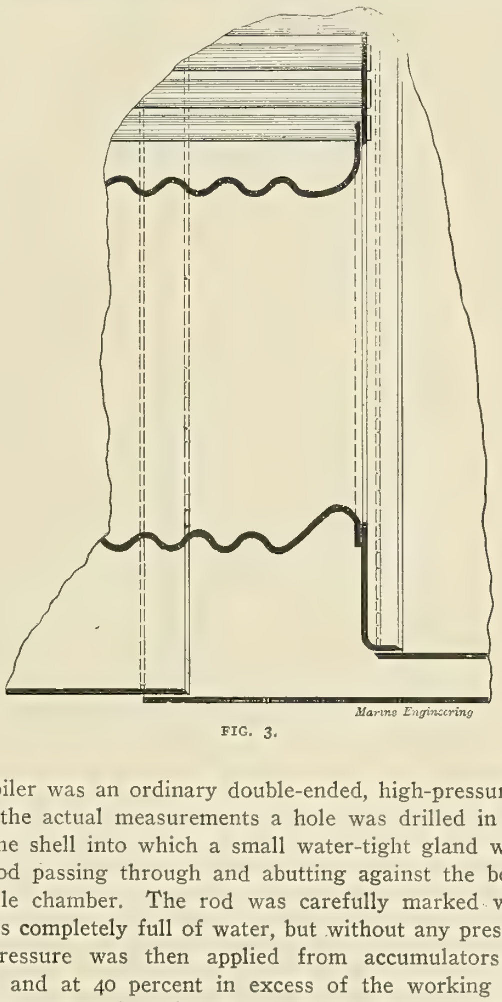


FIG. 3.

The boiler was an ordinary double-ended, high-pressure boiler. To take the actual measurements a hole was drilled in the bottom of the shell into which a small water-tight gland was fitted with a rod passing through and abutting against the bottom of the middle chamber. The rod was carefully marked when the boiler was completely full of water, but without any pressure. A steady pressure was then applied from accumulators on the premises, and at 40 percent in excess of the working pressure the test was stopped, as it was found the distance between the bottom of the shell and the chamber bottom had increased 7-16 of an inch. How much the movement would have been if the pressure had been allowed to go up to twice the working pressure can only be assumed; perhaps some of the wing stays would have given out, but the builders wisely accepted the results and decided to fit the stays.

Further evidence has been obtained of like results under actual working conditions.

The chief engineer of one of the large mail boats sailing out of this port furnished me with data showing that if the cleaning of a fire could be kept within a certain number of minutes no bad effects to the tube plate and furnace joints were observable; but when from dirty fires or other reasons the operation was protracted beyond the stated time leakage would commence and continue until the fire was well under way again. He also informed me, and this I personally observed, that where this leakage had taken place, careful inspection showed that the calking had been sprung by the lowered temperature, causing local contraction in the furnace and combustion-chamber connections.

The experiment was tried by putting two men to clean a fire so as to reduce the time required, and the results showed beyond a shadow of doubt that the leakage was directly due and proportional to the length of time the furnace door was open.

(2) This is usually observed after the furnaces have been in use for some time, and is generally found to develop about the middle of the length of the furnace in small hair-like cracks showing up on the points of the corrugations nearest to the fire. These faint cracks steadily increase in length and extend into one another until they become so bad that they require to be pinned or the furnace removed altogether.

The cracks in the furnaces are undoubted evidences of fatigue, produced from the stresses set up in a vertical direction by the unequal expansion and continuous movement due to the change of temperature between the upper and lower halves of the furnace and localized along the line of fire bars where the furnace is weakest, owing to the intense heat and excessive wear at this part. Cracks of a more serious nature sometimes develop in a circumferential direction in furnaces; this is not due to fatigue, but rather to carelessness in manipulation of the boilers.

A case came under the writer's notice some time ago where in a vessel the morning after arrival in port, upon the engineer's proceeding to examine one of the main boilers, that had been blown down 24 hours previously, they discovered a crack 20 degrees long in a circumferential direction in one of the lower furnaces. The cracked furnace was temporarily repaired, and upon the vessel's return to this country two months afterwards a crack of similar size was found under precisely the same conditions in one of the other boilers.

Inquiry elicited the fact that it was the practice to lay off for cleaning purposes one of the boilers in rotation, while the vessel was in port on this side, the *modus operandi* being to draw fires, blow down the boiler and drop in the manhole doors as soon as practicable after the vessel was made fast in dock.

It was pointed out to the engineer that this mishap was altogether preventable and was due to a lack of appreciation of the care necessary in handling boilers. The conditions were simply that the boiler in a limited space of time had all the heat and internal pressure removed and the empty boiler was then exposed to the chilling effect of a 36-inch down-take ventilator discharging in front of the boiler air of a temperature near to freezing point, as it so happened that it was in the winter months that the damage occurred.

Arrangements were made that in the future, upon the fires being drawn, the furnace door and ash-pit dampers should be closed, the ventilators turned back to wind, and the water left in the boilers to be pumped out next day, and since this has been done no further trouble with the furnaces has been experienced, clearly demonstrating how urgent the necessity is for a better appreciation of the care requisite in dealing with boilers.

(3) Cracking in the knuckle of the flanging of the lower front heads and distortion of the boiler bottoms is in some cases a serious trouble from the very start, due in a great measure to design. These stresses at these parts are very severe indeed, in some cases causing rupture of the shell plating through the line of circumferential riveting in the bottom of the shell, and cracking along the knuckle of the flanged part in the lower head. Investigation has demonstrated that to the differences of temperature between the top and the bottom of the boiler, causing unequal expansion of the shell plating and boiler ends, is due the distortion previously mentioned. Leakage at the boiler bottoms is difficult to cure, as heavy plating and rivets cannot be efficiently laid up by hand, and least of all in a confined space under a boiler bottom.

The flanging of the lower heads when examined inside show fatigue markings similar to the fine cracks shown on the fire side of the furnaces, and these in time develop upon the outside of the flanging also, and becomes so serious as to require the lower head to be repaired or renewed.

This cracking is found to develop at an early date in boilers where the flanging is of a small radius, showing that the plate in its efforts to accommodate itself to the changes of temperature and the movement resulting thereupon had been distressed, and of course where the material is fatigued to this extent there is a known limit to its endurance.

The lower heads also suffer from wasting caused by the water draining from the hot ashes corroding the fronts of the boilers. This, however, is to a great degree preventable and can be taken care of.

The lower heads as a result of the excessive flanging done upon them are peculiarly susceptible to corrosion on the knuckle of the flanging, and where this wasting is allowed to go on fatigue of the material follows very rapidly, and where rupture takes place at this part it is a difficult and costly business to repair, coupled with the fact that it can never be kept tight.

Boiler making has become a science of considerable exactitude, and with the excellent materials and tools now in use there can be no excuse for bad boiler work.

If boiler shells were ideally circular and could be kept so, if the flat surfaces could be so stayed that the various forces were balanced at all stages, then ideal conditions would have been obtained; but as the shell is distorted from its true form by various internal stresses, such as staying compensation for hole cutting, etc., the end plates which are so widely dissimilar in the areas under pressure that the staying can only approximately meet the stresses, show, and that very forcibly, how vitally important it is that all the possible conditions should be carefully thought out and amply provided for in a boiler design.

It cannot be too strongly urged how desirable it is that boilers should be kept free from scale and dirt.

Incrustation and corrosion go hand in hand. It is seldom that scale is removed without disclosing oxidation.

Stromeyer estimates that scale offers one hundred times as much resistance to the passage of heat as an ordinary steel plate of the same thickness, while a film of grease shows a resistance ten times greater even than scale, and as scale found in marine boilers always contains a certain proportion of grease, it is at once evident how serious the deterioration in a boiler may become when working under these conditions.

Good design, or the best class of workmanship, count for little if the boilers are allowed to get dirty and form scale, plating bulges, furnaces collapse, tubes leak, and all from causes that care and attention would in most cases have obviated.

At present many owners consider it cheaper wherever possible to use fresh water altogether for the boilers, rather than meet higher coal bills and the expense of scaling. Grease deposits in boilers have been to a large extent eliminated by the use of filters, and also from the disuse of cylinder and piston-rod lubrication to a large extent. Of course, it is well known that feed filters, however efficient, can arrest only the solid matter contained in the feed water, leaving whatever may be carried into the boilers in solution to be dealt with by zinc plates and other detergents which are used in boilers for this purpose.

The boiler question could not be dropped at this stage without considering the suitability and maintenance of water-tube boilers in merchant ships. The boilers in merchant ships must be capable of continuous working at the maximum. Reduced weight can be only of relative importance, except in very large installations, and should never be accepted at the sacrifice of reliability.

A brief examination shows that the principal claims made on behalf of the water-tube boiler are:

(1) Reduced weight per square foot fire grate.

(2) Reduced weight of water per H. P. developed.

(3) Greater adaptability for higher pressures without increasing weight.

(4) Greater facility for raising steam without injury to the boiler.

(5) Greater facility for repairs or renewals without disturbance of the ship's internal structure.

It is not proposed to examine or discuss the above points from the theoretical or constructional side, as that has been dealt with ably by Admiral Melville in the proceedings of this Society, and many other writers elsewhere, but rather to deal with the question of the suitability of water-tube boilers taking the place of the present shell boiler in merchant ships large and small.

(1) The difference of weight alone will not have much influence with the owner of the smaller vessels, such as the average tramp steamer with two or three boilers, as he has to consider the fact that his stoke-hold crew, and to a greater or lesser extent his engineers also, are continually changing, and that the vessel may at any time be in a port where the materials for the repair of water-tube boilers could not easily be had, and, beyond all, the necessity that he should provide ample means for a fresh-water feed make-up to meet the losses which, though common in all boilers, experience has shown are certainly not less in water-tube boilers.

In large installations the question of weight becomes of greater importance, as in the case of a ship where the boiler-room weights are, say, 1,200 tons, the reduction in weight is considerable in view of the builders' claims that the saving in favor of water-tube boilers is not less than 30 percent. This coupled with the very much greater saving in weight of water carried in the boilers are all-important factors to the naval architect and engineer, who are striving to produce a certain tonnage and horsepower on the least safe weight.

Everything else being equal the desire of the ship owner to save weight is just as keen as the builders, but it is here that the dividing line in engineers' minds is so sharply drawn, as it is contended by many that the saving of weight by the adoption of water-tube boilers is at the sacrifice of continuous and reliable working.

It is not upon the failures of the past that the water-tube boiler is to be condemned, but rather on the present and the prospects for the future that it is to be judged. There have undoubtedly been many bad water-tube boilers built, but there have certainly been plenty of bad shell boilers built also, and the present-day shell boiler, which is the outcome of long experience, bears little resemblance to the article that was produced forty years ago.

What the water-tube boiler has suffered from largely in the past has been an unripe advocacy of their use; the boilers have been installed in ships where the conditions under which they had to work were as little understood by the builders as the new type of boilers were by the engineers, the consequence being that in many cases the boilers failed utterly and were taken out, and it was only a courageous owner who would make a second venture in water-tube boilers.

The water-tube boiler of the present day bears little relation to that of even ten years ago. In the construction of this type of boiler at present castings have been altogether eliminated, and the highest quality of steel is now used for all purposes entering into construction, and this in combination with the superior tools now used in this class of work has resulted in producing a generator the workmanship of which is excellent. The question as to which type of boiler is most suitable for merchant ships, the maintenance of which shall be normal and which shall be capable of working at its maximum for lengthened voyages, has been engaging the attention of engineers all the world over for the last five years, to a greater extent than it has for the past twenty years, and the opinion is steadily but as surely growing, that given the proper type of boiler for the specific purpose in view, and due provision made for meeting the new conditions, there exists no well-defined reason why the water-tube boiler should not be successful. The British Boiler Commission, that has just completed its labors, has, after most extensive tests, unhesitatingly decided in favor of water-tube boilers.

It has not always been the fault of the boiler that has led to condemnation, but more often on the part of the engineering complement, both afloat and ashore, to thoroughly appreciate and understand the new conditions involved, nervousness and lack of patience contributing in no small measure to disaster.

(2) The reduced quantity of water carried in water-tube boilers is to a considerable extent offset by the necessity of an increased quantity of fresh water carried in the double bottom for make-up feed, and experience has shown that the percentage of make-up feed required in water-tube boilers is much higher than in the case of shell boilers. Some boilers have been tried with partly salt water, but I do not think engineers are yet prepared to adopt that course, but rather to get as pure a feed as ever possible.

Water-tube boilers mean the installation of evaporators of greater capacity, unless the voyage is short, as ships cannot afford to carry large quantities of fresh water and so shut out cargo. The greatly reduced quantity of water carried in the boilers is

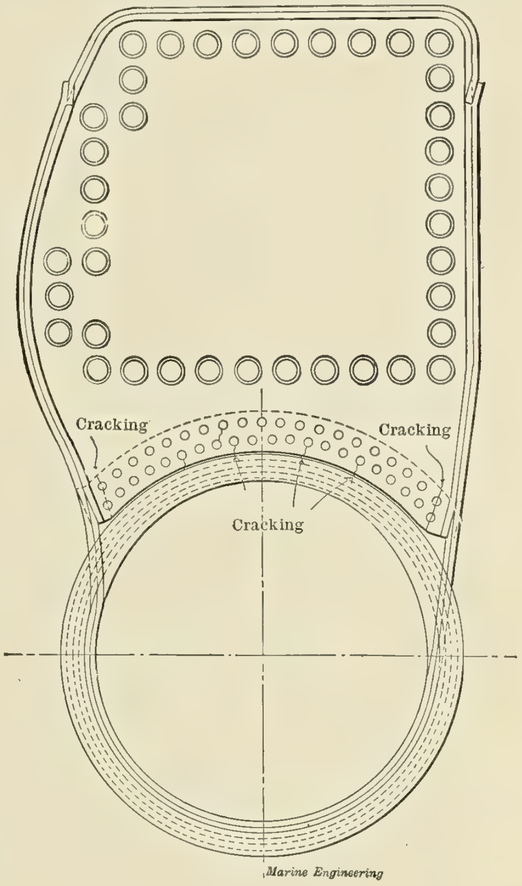


FIG. 4.

from one point of view a drawback, as the margin of safety between "water" and "no water in the glass" is very materially reduced. In a shell boiler the loss of water in the glass from priming or any other cause is not immediately serious, and the boilers can usually be handled with safety until the water is restored, but in the case of the water-tube boiler the loss of water in the glass is instantly dangerous.

It may be a simple matter to figure out what length of time may elapse from the time the water disappears out of the glass until the boiler is in jeopardy, but few engineers are prepared to take such risks, in the ordinary pressure of stokehold work, as a boiler failing to show water is an unknown quantity and should be put out of active use to prevent mishap. This danger from shortness of water in the large tube type is not so acute as it may be in the small tube or express boiler, but in any case the slightest derangement of the feed becomes serious immediately.

Complicated feed arrangements have in the past been altogether too prevalent with water-tube boilers, and have caused a corresponding amount of trouble and damage, but arrangements of greater simplicity are now being fitted, and there is every reason to expect the feed arrangement of water-tube boilers to be just as simple as in the ordinary shell boiler.

(3) There is no question of doubt as to the flexibility of water-tube boilers, when it comes to the question of higher pressures, without increasing the weight to any material degree, as the steam drum is the only member requiring to be considered. This factor is only of comparative value at present, as the most recent development hardly indicates that higher pressures are being seriously considered, the tendency being to obtain greater economy by other arrangements.

(4) With shell boilers, where well thought out, and feed and boiler circulating arrangements have been adopted, there is little likelihood of damage by raising steam quickly. When the pipe arrangement is so designed that the pump can draw water from the bottom of the boiler and circulate it back through the feed heater at boiling point by the feed check into the boiler, the expansion of the boiler goes on gradually and easily, and fires can be started and steam raised in a few hours without any resulting damage. It is, however, not desirable to raise steam too quickly, nor is it often found necessary in merchant ships to do so, as they usually have scheduled times for sailing or they are so situated that due notice can be given.

In ferryboats, where the vessel is kept closely at work or in ships other than merchant ships, this factor is no doubt of great value, but in merchant ships it can be of only minor importance.

(5) The necessity of making provision to allow for renewal of a ship's boilers is never considered during construction, although it has to be faced in many ships during their life time, and is always a costly and tedious business, involving much loss of time and damage to the ship's internal structure.

Where the opportunity has admitted of boilers being well taken care of and a long life of work of upwards of twenty years has been gotten out of them, many owners do not consider it a good investment to reboiler a more or less obsolete ship, as the extra expense due to reboilering is very considerable in old ships for the renewal of decks, tank-tops, bunkers, etc.

Where boilers require to be renewed, the fact that the water-tube boiler can be split up into its separate members and passed either through the funnel opening or through a bulkhead is of undoubted advantage to the owner, but I am convinced that the two points (1) and (2) are the all-important questions that will be considered by engineers and others as to what type of boiler is suitable for merchant ships.

There is not, in my opinion, any sound mechanical reason why water-tube boilers should not work well—enterprise and patience will demonstrate this assertion—experience and confidence on the part of the personnel will be gained, better baffling will result in an improved efficiency and economy, just as spiral retarders have improved the economy of the shell boiler, and as the boilers come into more general use they will be better understood, and will, without doubt, be improved, and become as reliable as any other type of boiler.

The successful working of water-tube boilers lies in the more highly capable and intelligent management of the stokehold.

Forced Draught.—Forced draught has certainly been a most valuable development in engineering, the proof of which need not be presented here; the main question arising in this paper being the effect that forced or accelerated draught has had upon the life and maintenance of boilers.

The two systems to be found in merchant ships are "Howden's Forced Draught" and "Ellis and Eaves Induced Draught," each of which in competent hands is capable of working the boilers at a very high efficiency. The closed stokehold system has confined itself largely to war ships and will not be considered here.

The effect of forced draught upon some boilers has been very marked indeed, and the question is of far-reaching importance as to what is the best air pressure to be carried in the ash pits. In some vessels 1-2 inch is considered sufficient, and is then really an assisted draught, while in others pressures up to about 3 inches are carried in the ash pits. It would almost seem as if somewhere between those two extremes would be found the desirable mean, but after close observation I am firmly of opinion that in shell boilers at all events the pressure in the ash pits should not exceed 1 inch of water at any time. I have examined many boilers where high air pressures have been in use, and the results have always been the same—buckled and cracked plating, stay-nuts burned off, calking started, and leaky tubes, whereas, when the air pressure was not allowed to exceed 1 inch the condition of the boilers was as good as those working under natural draught.

The maintenance of boilers under the higher air pressures is altogether out of proportion to the extra work got out of them, with the further result that a continuance of these higher pressures will cut out not less than 30 percent of the useful life of the boiler. The further objection to high air pressures, and it is a potent one, is that there can be no attempt at coal economy with excessive pressures, as experiments and trials without number have fully demonstrated. The temptation is keen to use higher air pressure when making up time, when coal is bad, or in the endeavor to get a power out of the boilers that their size does not warrant.

These remarks can be applied to water-tube boilers also, although their physical condition is not so seriously affected as the shell boiler; but experience will show that even there a moderate air pressure in point of maintenance and coal consumption will be found more than desirable.

Oil Fuel.—The maintenance of boilers working with oil fuel is, at the present time, of decided interest, in view of the possible development in this direction. It is not proposed to deal with the question of oil as a fuel, but rather to consider its adaptability and its effect upon boilers. The use of oil fuel has been with a few exceptions confined to oil-carrying steamers, but there is not any structural reason to debar its use in ordinary cargo or passenger ships, as the fuel can be carried in the double bottom and in tanks fitted in the usual coal-bunker spaces. With proper precautions taken the risk of explosion is very remote, as the flash point of the fuel is usually not less than 150 degrees Fahrenheit.

When the fuel is carried in the double bottom a heavy layer of cement 3 inches thick, properly sectioned off to keep it in place, has proved to be a good insulator for the tank.

The two systems most widely applied to burning oil fuel are compressed air or spraying by steam.

The former requires a small air compressor, or other suitable means for obtaining the required pressure, which is usually about 1 inch; the other method, spraying by steam, requires the installation of extra evaporators to make up the loss of water used in spraying the oil, which is found to be about 3 percent of the total steam evaporated. With the compressed air a certain amount of steam is, of course, required to drive the air compressor, but there is no doubt that with the air heated to a high temperature this process will be found to show a high efficiency, especially in long voyages, as under oil-fuel conditions the combustion and the steam are steady, which always means economy.

The condition of the boilers after using oil fuel is found, when the necessary safeguards have been taken to protect the surfaces of the combustion chamber from direct impact with the flame, not to differ to any material extent from that of boilers burning coal.

The combustion chamber backs and sides require to be protected with brick work carried up above the level of the furnace crown, and in most cases the furnaces are bricked over also, and arrangements of brick arches erected in the furnace to baffle or break up the torch-shaped flame within the length of the furnace. When these conditions are properly carried out the boilers show not the slightest sign of distress, but if the brick work is allowed to come down it means that the flame strikes straight through into the chamber; the furnace does comparatively little work, intense heat is localized in the combustion-chamber back and tube plates, causing serious distortion and leakage.

I have examined boilers that were less than twelve months in use, where the combustion chambers were seriously damaged from neglect to keep the brick work in good condition. The burning of oil fuel is supposed to be a simple operation, and so it is when we know how to do it.

There is every reason why boilers should work well under oil fuel. The temperature of the gases of combustion varies but little; there is no opening of furnace doors and cleaning fires; the men readily handle it intelligently, and the maintenance of boilers working under oil fuel should, in capable hands, be less than under coal conditions. The drawback at present to its wider use seems to be more commercial than mechanical.

Superheating.—The interest now being taken in the question of superheat seems to indicate that we have arrived at another period in the cycle of development in engineering.

When steam pressures ranged from 40 pounds to 80 pounds superheaters of many types were in general use, and were considered almost indispensable, and at these low pressures they certainly were of value; but with the advent of the triple- and later the quadruple-expansion engines, superheaters went out of use.

The whole aim of engineers for some considerable time past has been to seek for the improved economy in higher steam pressures, the quadruple following the triple when pressures rose above 180 pounds per square inch, and later, in the case of the *Inchdune* and other ships for the same firm, the five-crank engine was developed with Scotch boilers working at a pressure of 267 pounds per square inch.

Engineers are now convinced that if any further economy is to be reached by higher pressures, a very radical departure will require to be made from the present type of engine and boiler. The times would seem to be propitious for this change, as shadowed forth in the development of the steam turbine and the more general use of water-tube boilers, but even in the turbine it is recognized more fully than in the reciprocating engine that there are great possibilities for a higher efficiency and economy by the use of superheated steam. Dealing with the present reciprocating engine, it is well known that the moisture or water particles in the steam act as a lubricant for the leakage of the steam between the piston and the cylinder walls; this leakage being excessive in the case of many piston valves; and as piston valves by reason of their equilibrium under working conditions are now very widely used, it is recognized that with steam of an increased volume and more closely approaching a gas, leakage will be less likely to take place and efficiency will be improved.

It is not proposed in this paper to deal with the development of the steam turbine, but reference may be made to the fact that superheating can with perfect safety be carried to a much greater extent and with corresponding advantages in the turbine than would be possible in the reciprocating engine. In the turbine there are no surfaces such as cylinder walls, valve faces, piston rods, etc., so that no limitations to the amount of superheating will be met with in the machine. In the reciprocating engine it will be very different, as there very high dry temperatures may readily cause abrasion of the surfaces; but it is not considered that from 100 to 150 degrees Fahrenheit of superheating will produce conditions that cannot easily be dealt with. It is in the multiple method of superheating wherein the greatest possibilities seem to lie; that is, in superheating the steam on its way from the boilers to the engine, and then after doing work in the cylinder it is passed through another heater, and so on to each succeeding cylinder, the steam being superheated in each change. This no doubt means a certain amount of complication, and perhaps weight, but as it must increase the efficiency of the steam quite considerably the extra weight in superheaters, it is claimed, will be equalized by the reduced boiler weights required. If superheating be applied to the initial stages alone, a decided gain would result by getting rid of the water brought over by the steam from the boilers by priming or other causes, and would result in lessened leakages at the engine and get useful work out of a certain proportion of the steam that would otherwise, by condensation, become inert. Of course there are many objections to superheaters which are well known and need not be recapitulated here, but there is not the slightest doubt that with the renewed interest now being taken in this subject, superheaters of a widely different type from those of the past will be developed.

There would, of course, be a certain percentage of drop in the pressure, due to the friction and wire drawing through the passages and connections of the superheater, but with well-designed apparatus this drop should be only small, and would be more than compensated for in the higher quality of the steam.

The whole question of superheat is likely to lead to considerable development in the early future if engineers are able to overcome the objections of the ship owners to what many consider only an added complication.

Main and Auxiliary Steam Pipes.—The necessity for a good pipe arrangement was never greater than at the present time. As stokeholds extend in length the demand for well-designed main steam pipe lines is very urgent, so that the losses from drop in pressure between the boilers and engines should be kept as low as possible. As long lines of steam pipes have considerable movement when under steam, the greatest care should be taken to avoid any abrupt changes in the direction of the line of piping, and where it is found necessary to make changes, expansion joints should be fitted and so arranged that it will not be possible to subject the bends and other connections to any stress beyond that due to the boiler pressure. Main steam-pipe flanges should not be bolted to bulkheads unless expansion joints are in the immediate vicinity, and so arranged to take up any movement in the bulkhead that may take place; and never under any consideration when struts carried from any other part of the machinery are attached to the bulkhead in proximity to the steam pipes, as grave danger is to be apprehended in this arrangement in the event of the vessel grounding or meeting with other serious damage. Long lines of steam piping mean considerable condensation, and ample means should be taken to ensure this water being trapped, and where this is done automatically hand drains should also be fitted, so that in the event of any of the lines being laid off temporarily, the engineer will always be able to inform himself as to whether the pipes are clear of water before turning steam on.

The arrangement of auxiliary steam lines in many cases leaves much to be desired; pipes are dropped down to low levels to get round some obstructions, then raised abruptly to higher levels, thus forming a pocket which is a lodgment for water, and besides being a positive danger, it lowers very materially the efficiency of the whole auxiliary outfit.

I am perfectly familiar with the fact that all pipe arrangements are a compromise from beginning to end, the ship's structure and other considerations requiring to be dealt with at every step, but I am convinced that where careful attention is given to the detail of the whole arrangement much greater satisfaction will be obtained, and the wear and tear on the steam end of the auxiliaries will be correspondingly reduced. Few auxiliaries can lay claim to a very high steam efficiency, this being due in no small measure to the quality of steam with which they are operated.

It is not possible to lay down any lines upon which a pipe arrangement should be designed, the exigencies of each case requiring special consideration, but the chief aim should be to avoid complications; the use of cast iron in any form should be forbidden, copper bends and expansion arrangements being fitted to accommodate the movement that takes place in the long stretches of auxiliary steam piping.

Pumps.—One of the greatest advances made in the development of the present triple or quadruple engine has been in relieving the main engine of the duty of driving the pumps and using the power for propelling the ship only.

The long-stroke, slow-working simplex feed pumps now in use, when fitted with automatic speed regulators, give good results;

the feed line is not subjected to shocks and as the pump works only when there is water to pump, it means that less air is forced into the boiler along with the water. As the water ends of high-class feed pumps are of brass, the valve seats should be cast solid with the chamber; removable seatings that are only "driven in" should not be accepted, as they are sure to become loose unless they are well secured in place by screwed pins through the flanges into the chamber, and as these pumps require to pump water that is well over 200 degrees Fahrenheit against a high pressure, this class of pump requires to be of substantial make and the best workmanship; otherwise they are a continual source of trouble.

One other good feature of the independent feed pump, especially in large installations, is that they are usually fitted in pairs and interchangeable, which means that the breakdown of a feed pump is not so serious as formerly, and as most pumps of this class have considerable reserve capacity any mishap occurring to put a pump out of action does not affect the speed of the vessel.

The whole array of auxiliary or independent machines, such as feed, bilge, ballast, air, circulating and sanitary pumps, electric light, blower and ventilating fan engines, etc., now usually fitted, are an elaboration of the idea of separate units for each particular service, and have in most cases been found to do their work remarkably well; but it has to be remembered that the maintenance of such a large number of steam users, in even a moderate degree of efficiency, entails a large amount of work and expense, and as many of these auxiliaries are so placed that examination and repair are difficult to accomplish, it can be easily understood that they are neglected and become most uneconomical steam users. This feature of auxiliaries is perhaps not much considered, but investigation will disclose what a surprisingly large proportion of the boiler power is absorbed in driving the auxiliary machinery.

Electric power in some cases has been made use of for driving quick-moving auxiliary machinery, such as blower and ventilating fans, centrifugal pumps, etc., and that there is a wide field for electric power in this direction is undoubted, for although the first cost of the electric installation is greater the up-keep and losses are much less. There is at present a certain amount of distrust in the minds of many engineers against electric motors taking the place of the steam engine when a positive action is demanded. That there is considerable force in this objection will be realized in the event of the motor attached to the circulating pump breaking down when leaving the dock, and bringing the engines up from lack of vacuum, and there is this further danger, that, as circulators are carried low down, an excess of water in the engine room might very easily put the motor out of action altogether. Notwithstanding the objections against the use of the motor, I firmly believe that their use will become general where continuous running is required, and if the motors are properly cared for and not overloaded, satisfactory results will be obtained. Cross-connections are always arranged for to provide against such contingencies as the breakdown of the circulator, but unless electricians can produce a motor, proof against the effects of oil and salt water, circulators should not be electrically equipped.

Small steam turbines, for which a fair economy is now claimed, seem well adapted for high-speed continuous running; their action is positive, and the wear and tear is practically *nil.* The whole question of the adaptability and location of auxiliary machinery is now receiving very much better attention than hitherto, and rightly so, as a bad arrangement of this very important factor is a serious drawback; the up-keep is excessive, breakdowns are continuous, and are most harrassing to the whole engineering staff, as it means continual toil from port to port, and all from causes that experience might well have prevented.

The question as to the best steam pressure, in point of economy and efficiency, for operating auxiliaries, is of decided interest. It does seem an anomaly to raise steam up to the high pressures in use at present, about 210 pounds, and then wire-draw it through a reducing valve down to 100 pounds to make use of it.

Few auxiliaries are well adapted or kept in such mechanical efficiency to profitably use steam of the higher pressures, as the losses from radiation and condensation and other leakages are considerable, and as auxiliaries are not an afterthought, it would undoubtedly seem to be a better arrangement for a certain proportion of the boiler power to be designed for the lower pressure. The first cost would be decidedly less, as the price of boiler power and all the necessary fittings for 100 pounds steam pressure is very much lower than it would be for 210 pounds. Some vessels have been arranged along these lines and the results have been very satisfactory indeed.

GENERAL.

There are many other points that might have been incorporated in this paper, such as feed heating, use of evaporators, filters, etc., but enough has been dealt with to show that the efficient maintenance of machinery at the present day is a living complex reality, and demands from those who have to take up the responsibility a high order of intelligence and unremitting care.

The later developments have unquestionably demonstrated that rule of thumb methods are no longer admissible, and where such valuable property is at stake the best in design, material, workmanship and supervision is demanded, and only the best should be accepted.

The Engines of the English Armored Cruiser Argyll.

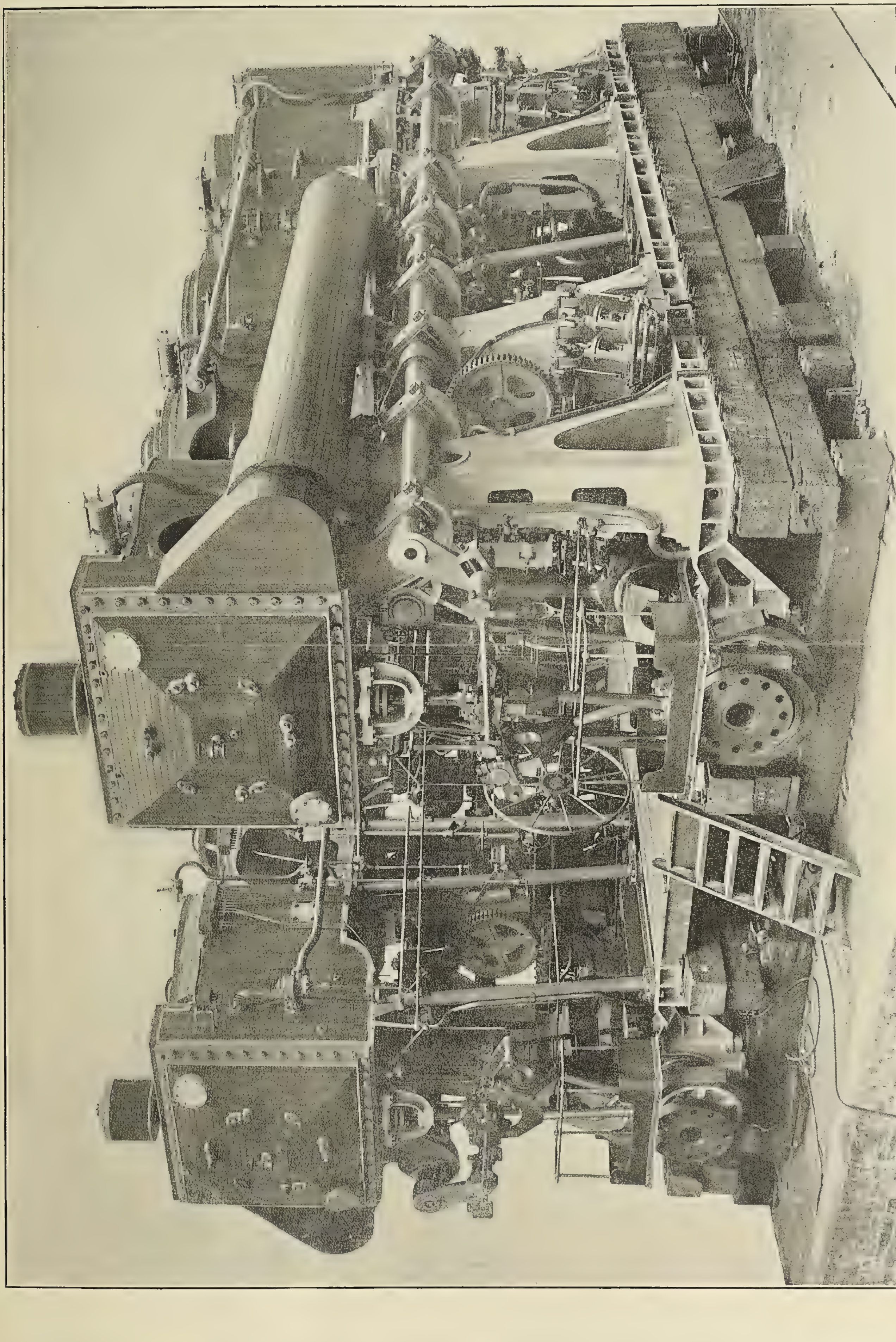
We reproduce from *Engineering* a photograph of the twin engines of one of the latest armored cruisers in the British navy, which is now undergoing completion. The ship has a displacement of 10,700 tons at a mean draft of 24 feet 9 inches. She measures 450 feet in length between perpendiculars, 68 feet 6 inches in beam, and has a molded depth of 38 feet 6 inches. The engines are designed to develop a maximum of 21,000 horsepower, at which power the designed speed is 22.25 knots.

There are two sets of four-cylinder, triple-expansion engines, arranged as usual in separate water-tight compartments. The diameters of the cylinders are as follows: high-pressure, 41 1-2 inch; intermediate-pressure, 65 1-2 inch; and low-pressure, two of 73 1-2 inch; all having a common stroke of 42 inches. All of the cylinders are steam jacketed and fitted with liners. The pressure carried is 205 pounds at the engines, and a speed of revolution of 138 per minute will be required to give the designed speed of the ship.

The high-pressure and intermediate-pressure cylinders are fitted with piston valves, and the low-pressure cylinders with flat side valves; the former are 28 1-2 and 46 1-2 inches respectively in diameter. The main steam pipe to each engine has a diameter of 16 1-4 inches and the exhaust of each low-pressure cylinder has a diameter of 28 inches. The high-pressure and intermediate-pressure piston rods are 9 1-2 inches in diameter, while the low-pressure piston rods have a diameter of 7 1-2 inches.

The cylinders are supported at the front by eight forged steel columns, and at the back by four cast-iron columns formed with guide faces, and one forged-steel column. The forged-steel columns have diameters of 6 1-2 and 5 3-4 inches. The bed plate is made of cast steel of I-section, and has in it eight main bearings of an aggregate length of 14 feet 8 inches. The shafting is hollow throughout, the crank shaft being 18 inches in diameter with a 9-inch hole. The crank pins have a diameter of 20 inches and a 10-inch hole, those for the high-pressure and intermediate-pressure cylinders being 26 inches long, and for the low-pressure 17 inches. The thrust shaft is 17 inches in diameter with a 9 1-2-inch hole.

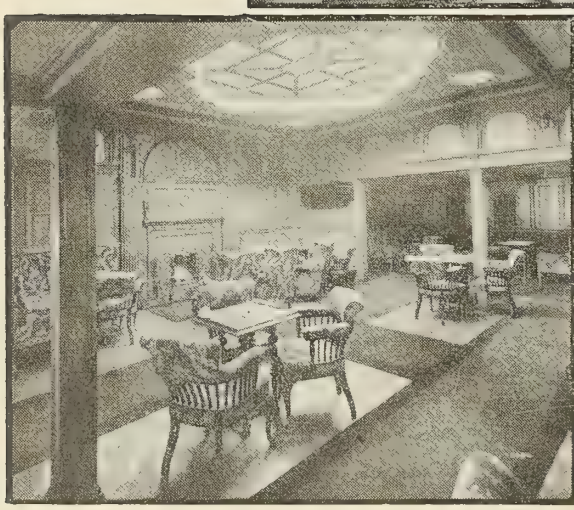
Steam is provided by sixteen Babcock and Wilcox water-tube boilers with an aggregate heating surface of 45,847 square feet, and a total grate surface of 1,177.5 square feet, the ratio of heating surface to grate area being thus 39 to 1.



THE TWIN ENGINES OF THE ENGLISH ARMORED CRUISER ARGYLL.

THE CARONIA.

FIRST CABIN SALOON.



SMOKING ROOM.

THE NEW CUNARD STEAMSHIP CARONIA.

Leaving Liverpool on the 25th of February, the latest of the Cunard steamships reached this port, on her maiden trip, on the 5th of March. The *Caronia* is considerably the largest of the Cunard liners now in service, having a length over all of 678 feet, a beam of 72 feet 6 inches, a depth to shelter-deck of 52 feet, to boat-deck 80 feet, and to bridge-deck 97 feet. Her gross tonnage is 21,000, which is almost identical with that of the *Cedric* and *Celtic* of the White Star Line, and the *Minnesota* and *Dakota* of the Great Northern Steamship Line, and but little short of the 23,500 of the *Baltic*, which is the largest ship afloat. On a draft of 33 feet the *Caronia* displaces 31,200 tons.

She is one of two sister ships, the other being the *Carmania* launched on the 21st of February, and to be propelled by turbines. The keel plates were laid in September, 1903. The *Caronia* was launched the following April, and thus has started on her life work only seventeen months after the laying of the keel. Her launching weight was 13,500 tons, while the completed ship, exclusive of coal and cargo, weighs 20,000 tons. She is built with a cellular double bottom, which is carried well up the sides of the ship above the bilges, and which enables her to carry 3,500 tons of water ballast, and thus make up during a voyage for the consumption of coal and stores and maintain the steadiness with which she started out. For 250 feet amidships the hull is fitted with bilge keels, and the combination of structural stiffness, bilge keels, and provision for water ballast will doubtless result in a remarkably staunch and seaworthy ship.

The side plating is put on in strakes varying from 60 to 66 inches in breadth and 3-4 to 1 1-8 inches in thickness, and with a maximum length of plate of 32 feet, the average weight of plates being about 3 tons. The rivets in the hull are all of mild steel and number about 1,800,000; some of those used in the bottom, where there are doubling strakes along the keel, are as much as 7 inches in length and weigh each 3 1-2 pounds. The vessel is fitted throughout with the Stone-Lloyd system of water-tight bulkhead doors, by which all the passages through the numerous thwartship bulkheads may, if necessary, be closed simultaneously from the bridge, and by means of which each separate door may be opened or closed at will. An automatic device in each compartment operates to close the door of that compartment whenever a certain depth of water is reached in it. By this method the most complete security obtainable is insured. In order to counteract the effects of corrosion within the skin of the ship, particularly in the ballast tanks, bunkers, and other remote portions of the hull, the hold has been coated with bitumastic enamel.

The *Caronia* has eight continuous decks, the uppermost being the boat-deck, the others, leading downwards, the upper promenade, promenade, saloon, upper, main, lower, and orlop decks. For the convenience of passengers not acquainted with the nautical names given these decks, each one has also received a letter, beginning from above, A, B, C, D, etc.

The navigating bridge, which surmounts the main superstructure carrying the first and second-class quarters, is built in and faced with glass, so as to afford protection to those in charge of the ship, and to secure better results by promoting the comfort of those responsible for her direction. A large number of telegraphs and telephones are located in the bridge house, in order to facilitate communication with other parts of the ship as it may be necessary. Beneath the navigating bridge is a steel house on the boat-deck, the forward end of which is fitted up for the captain and chief officer, and the after end for the junior officers. These all connect with both the outside-deck and the saloons below. A Marconi station is situated just forward of the after funnel, on the boat-deck.

The forward end of the boat-deck, as well as the two decks next below, are set aside as a promenade for the saloon passengers. Connecting with the boat-deck, somewhat aft of the officers' quarters and immediately aft of the forward funnel, is an elaborately fitted and furnished apartment, paneled in mahogany and old-gold leather, the upholstery and carpeting being uniformly of a dark shade of peacock-blue green. This apartment, which measures about 36 feet square, is known as the "lounge," and forms a common meeting point for passengers, in the most informal way. At the after end of the lounge is a buffet whence coffee and light refreshments may be obtained.

Below this are found a number of first-class state rooms of the highest grade, which are, generally speaking, unsurpassed by anything afloat both in roominess, decoration, furnishings, and appointments. Many of these rooms are connected *en suite*, comprising sleeping and sitting rooms, bath, and lavatories.

On this deck (upper promenade, or "A,") are also the writing and drawing rooms, in both of which the wainscotting is white with tapestry paneling. The ceilings are of the same color, and the rooms are plentifully supplied with luxurious couches, settees, and easy chairs, the general effect of comfort being much enhanced by the presence of an open fireplace. The carpeting, of rich red, is in perfect harmony with the curtains, the drapery at the two entrances, the table covers, and the shades of the lamps. These two rooms open into each other, thus forming virtually one apartment, measuring about 47 feet forward and aft and 32 wide. The situation is amidships, between the two funnels.

At the after end of this deck is situated the smoking room, surmounted by a fine skylight. The paneling and furnishing is in dark oak and the upholstery in figured cloth of mellow colors. A large, open fireplace, with mantel of hammered copper, adds a home-like touch to the appointments. The dimensions are about 30 by 48 feet, the length being athwartship.

THE CARONIA ON TRIAL TRIP.

The promenade-deck contains a great many first-class state rooms, as well as the barber shop, doctor's room, dispensary, typewriter room with stenographer, and a new institution—a candy store. The purser's department is a commodious office on this deck, and is fitted up very much like the counting room in a modern bank. A steel-lined treasure chamber, and an immense safe, are provided for the custody of such valuables as the passengers do not care to leave in their state rooms.

The first-class dining saloon is a very spacious apartment located amidships on the saloon or "C" deck. It extends from side to side of the ship, and for a length of nearly 70 feet. The arrangement of the tables is somewhat different from that usually in vogue, there being a circular table in the center and numerous smaller tables arranged around it, the whole accommodating the entire number (300) of first-class passengers carried. The wing tables are in alcoves, facilitating the gathering of small parties with considerable privacy. The decoration of this room is very largely in carved mahogany, with white enamel finish, and the furniture is very rich. The roof of this room is broken by a large octagonal opening, 24 feet across, forming a "clerestory," and surrounded above by a lounge. The angles of this opening are supported by fluted Ionic pillars, interspersed with panels in Jacobean carving. The same decorative scheme, in somewhat higher relief, is shown in the ceiling and in the frieze which surrounds the entire room, and harmonizes perfectly with the capitals of the columns. The draperies and upholstering are of a rich crimson, adding a decided warmth to the general tone.

The accommodation provided for the second-class passengers has been worked out on an elaborate scale, and has, indeed, been considered by some to be so far advanced as to be likely to cut down the receipts from first-class passengers. The third-class travelers are berthed in two-, four-, and six-berth rooms. The ship has a capacity for carrying nearly 3,100 passengers, together with a crew of 450 men.

The ventilation of the vessel is a strong feature, and has been worked out with the idea of securing natural ventilation wherever possible. In such parts of the ship as cannot be reached by this method, the most up-to-date apparatus is employed, and splendid results are anticipated. The heating of the ship has also received much attention.

The engines of the *Caronia* are of the quadruple-expansion reciprocating pattern, consisting of two sets, each capable of generating about 10,500 horsepower. The cylinders measure respectively 39 inches, 54 1-2 inches, 77 inches, and 110 inches in diameter, with a common stroke of 66 inches. The rotations of the shaft are 86 per minute when the engines are developing their full power. There is very little of the unusual in the engine rooms, but the set of auxiliary machinery is very complete, and the laying-out of the various items making up the total has been carefully done. The condensers are separated from the engines, and raised much higher than is usually the case, so that the view from the starting platform into the wings is much more open than is usual. The engines are balanced on the Yarrow-Schlick-Tweedy system with a view to minimizing as much as possible the vibration due to operation.

There are six stokeholds especially fitted with a system of ventilation partly natural and partly artificial, in order to produce much cooler quarters than are usually found in this department of transatlantic liners. The boilers number altogether thirteen, eight double-ended and five single-ended, and contain fifty-four furnaces, supplying steam to the engines at a working pressure of 210 pounds per square inch; a slight forced draft is used when the ship is under way. The equipment of the stokehold includes the fitting of Crompton atmospheric ash hoists of 8 inches in diameter, which lift the ashes 41 feet from the stokehold floor and discharge them overboard.

The illumination is, as usual, by electricity, and is very complete, there being over 3,000 lamps, besides the powerful searchlight. The dynamos are four in number, and each is capable of generating 750 amperes of current at a pressure of 100 volts. The refrigerating machinery and cold-storage plant is one of the largest ever fitted on board ship. The engines are situated on the main-deck near the foremast, and, in addition to cooling the specially insulated holds fitted for fresh meat and other vegetables, serve also for the cooling of other compartments of the ship as may be necessary. The steering gear consists of two sets operated separately by telemeter from the bridge, either of which can be used at pleasure. One of these engines is in a steel wheel-house on the shelter-deck aft, while the other is situated below the water-line, in order to meet the requirements of the Admiralty. Both are driven by steam power, and when one is in operation the other is automatically disconnected, and thus in no way interferes with the free action of the rudder. The upper gear is fitted over the rudder head, the lower gear being attached to a crosshead fitted on the rudder head. The latter is 19 inches in diameter, and the rudder, which is balanced, is of the most massive character, and is entirely below the water-line. The engines which work the rudder are carried on the tiller, and operate a pinion wheel acting directly on a massive toothed quadrant. Great power, steadiness, and strength are secured by this arrangement. The ship can be steered from either the wheel-house on the bridge, the shelter-deck, or the lower deck, the steering orders in the latter case being transmitted from the bridge by telephone or telegraph.

The bower anchors, which are of the stockless type, weigh each 8 1-2 tons, and have cables 3 3-8 inches in diameter. The windlass is placed forward below the shelter-deck, but the cable is carried up to the upper-deck before descending to the chain locker. Cargo stowage and unloading is made easy by the use of sixteen steam winches conveniently situated near the hatchways. Facilities are provided for dealing with 13,600 tons of dead weight. The bitts and mooring posts, with which the decks of the ship are elaborately provided, are on the same massive scale as all the rest of the equipment, and appear to be most satisfactory with regard to strength and reliability.

THE LOUNGE.

The trial trip of the *Caronia* occurred on the 4th of February. The speed condition required was 18 knots on the Atlantic passage with a normal load, and it was considered sufficient to stipulate that 19 knots should be realized on the measured mile, and maintained subsequently on a long-distance sea run. The mean speed on four runs on the measured mile was 19.62 knots, attained with the engines making an average of 89.2 revolutions and indicating 21,870 horsepower. Following these runs, the vessel proceeded to sea, and the same power and revolutions were continued for 13 1-2 hours, when the officials of the Cunard Line expressed themselves satisfied. Indicator cards were taken at regular intervals during the trial, and the highest power recorded was 23,500 horsepower. The results of the progressive speed trials are also now available. The speed of 15.72 knots was realized with one-half the engine power—10,400 horsepower—so that the four extra knots involved a doubling of the power. For 16.61 knots the power was 12,350 horsepower, for 17.76 knots it was 15,500, for 18.80 knots 18,900, and on this series the full speed of 19.51 knots required 21,600 horsepower. The amount of vibration recorded proved that it had been reduced to the minimum by the perfect balancing of the engines. These will be most instructive when compared with similar data obtained from the turbine-driven sister ship *Carmania.*

The *Caronia* has been specially designed for utilization by the British Admiralty as an armed cruiser, provision being made for the installation of twelve 6-inch rapid-firing guns whenever any emergency requires that the ship be withdrawn from her regular service and sent out with the fleet.

THE FIRST-CLASS DRAWING ROOM.

MARINE ENGINEERING DATA CARD. APRIL, 1905.

NAME—Caronia. NATIONALITY—British. TYPE—Ocean passenger and freight liner.
LAUNCHED—1904. BUILDER—John Brown and Co., Ltd. OWNER—Cunard Steamship Co., Ltd.

Length over all	678 ft. 0 ins.	**Engines:** Type	4-cylinder, quadruple
Beam, molded	72 " 6 "	Cylinder diams	39, 54 1-2, 77, 110 ins.
Depth, " to shelter deck	52 " 0 "	Stroke	66 "
Launching, displacement	13 500 tons	I. H. P., designed	21,000
Load, draft	33 ft.	" on trial	21,870
" displacement	31,200 tons	Shafting, diameter crank	22 1-2 ins.
Dead weight cargo capacity	12,000 "	" " tunnel	21 1-4 "
Gross tonnage	21,000 "	" " propeller	23 1-2 "
Water ballast	3,400 tons	**Boilers:** Type	Scotch
Speed at sea, designed	18 knots	Number	8 double-end; 5 single-end
" on trial	19.62 "	Steam pressure	210 lbs.
		Draft	Howden system
		Stacks above grate	135 ft.

A Collision on the Clyde.

The steamer *Kathleen,* of 1,017 tons registry, bound from Bilbao, Spain, to Glasgow, with a cargo of iron ore, and almost at her destination, was struck amidships by the steamer *Stromboli,* of 727 tons dead weight, bound for Valencia with a cargo of machinery, and almost cut in two. As a result both ships sank, but not before the *Stromboli* had succeeded in pulling the two wrecks into shallow water near the shore. We present a photograph showing the condition of the two ships at low water, at which

time it was ascertained that the ships were "toggled" together, the side plating of the *Kathleen* having pierced the bow of the *Stromboli* while the fore foot of the latter had punctured the engine bulkhead of the former. It is thought that the *Stromboli* may be saved, but as the other ship was cut almost entirely in two, she will probably prove a total loss. The photograph was taken by Mr. I. S. Willet of Greenock.

PRACTICAL POINTS ABOUT THE SCREW PROPELLER.

BY W. F. DURAND.

PART IV. *General Discussion of Relation Between Proportions of Propeller, Conditions of Operation, and Results to be Expected.*

(1) *Thickness of Propeller Blades.*

The thickness of the blade at the root has already been used in Part II, in connection with the laying down of the propeller on the drawing board. To determine its dimensions we may use the following formula:

$$t = A\sqrt{\frac{B}{n}}\,du.$$

Where t = thickness of blade at root in *inches*,
A = coefficient according to material, as given below,
B = coefficient drawn from table below,
n = number of blades,
d = diameter of propeller in *feet*,
u = speed in knots.

VALUES OF A.

For bronze or steel	.04 to .06
For cast iron	.07 to .08

VALUES OF B.

Pitch-ratio.	*B.*	*Pitch-ratio.*	*B.*
1.0	.91	1.6	.56
1.1	.83	1.7	.53
1.2	.76	1.8	.50
1.3	.69	1.9	.47
1.4	.64	2.0	.45
1.5	.60		

Thus for example:

Let diameter = 10 feet, u = 15 knots,
n = 4, pitch-ratio = 1.2,
material, cast iron.

$$\text{Then } t = .075\sqrt{\frac{.76}{4}} \times 10 \times 15.$$
$$= .075 \times .44 \times 10 \times 15 = 5.0 \text{ inches.}$$

Again, if diameter = 8 feet, u = 28 knots,
n = 3, pitch-ratio = 1.7,
material, bronze.

$$\text{Then } t = .045\sqrt{\frac{.56}{3}} \times 8 \times 28$$
$$= .045 \times .43 \times 8 \times 28 = 4.33 \text{ inches.}$$

(2.) *General Influence of the Four Factors a, b, c, e.*

These four factors, as discussed in the preceding chapter, have reference respectively to the influence of the ship-speed relation; the pitch-ratio; the slip; and the shape-area, or general form and proportion of the blade.

As the Admiralty coefficient is smaller and the ship-speed factor is larger, the propeller must be correspondingly larger, and this means, with all other considerations equal, that the propeller must be the larger, as the speed is the more disproportionate to the ship either in form or size. Thus a full-bodied small ship, if pushed to a relatively high speed, will require a relatively large propeller, and no juggling otherwise can fully compensate for a mistake made at this point.

Again, all other conditions remaining the same, it will be seen that the larger the pitch-ratio the larger the resulting diameter, and *vice versa*. In a general way, then, high pitch-ratios will carry with them large diameters, and are therefore more directly indicated when, due to other general conditions, such diameters are acceptable. If the diameter is to be reduced, then the reduction of the pitch-ratio and the acceptance of higher revolutions is one of the means available for bringing about this result.

The slip factor, on the other hand, varies inversely as the slip, which means that the larger the slip, the smaller the propeller, and *vice versa*. Working at a low slip always means a large propeller, and with a large slip a relatively small propeller.

Likewise, the more the area, with certain limitations as previously discussed, the smaller the resulting propeller, and *vice versa*. Thus, likewise, in a general way, a propeller with three blades will be of greater diameter than one of four, and one of two larger than one of three, simply because the less the number of blades the less the area readily carried and the greater the resulting diameter.

To sum up, it will be seen that with a given ship and set of general conditions, the smallest possible propeller will result with a low pitch-ratio operated at high slip and with a relatively large surface. This would not mean presumably an efficient propeller. It would simply represent the combination of all items tending toward small size, and at the same time relatively high revolutions. On the other hand, the opposite combination of high pitch-ratio, low slip and small surface would give an excessively large propeller and relatively low revolutions. Neither would such a combination necessarily give a propeller of good efficiency.

We will now turn briefly from size to efficiency in its relation to the various items under discussion.

It should be first understood that efficiency is chiefly a question of slip in relation to pitch-ratio. In a general way the best efficiency may be looked for with values of the apparent slip from 14 to 20 percent; the higher the pitch-ratio, the higher the permissible slip for good efficiency. In particular it should be understood that decreasing the slip will not necessarily increase the efficiency, and certainly not beyond the value for the best efficiency. Still lower values of the slip will give decreased efficiency and greater operative loss throughout. Too low slip is therefore quite as undesirable as too high, and, in fact, experiment shows that efficiency falls off more rapidly as the slip is reduced below its best value than when it is increased above such best value. It will be therefore better to operate at five percent above the best value of the slip than at five percent below. Variations of area within moderation have but slight influence on the efficiency, and area may be added freely up to values of the area-ratio as large as .50 without fear of ill effect on the efficiency, except for low pitch-ratios. Here, in a general way, large areas should be avoided, and for values of the pitch-ratio about unity, the maximum area-ratio should not much exceed .40. From these considerations we may readily derive certain indications regarding the steps to be taken in case the trial results are different from those expected or required. Thus suppose: (*a*) The boilers furnish plenty of steam, but the revolutions are too low, the expected indicated horsepower is not developed, and the speed is not attained. This condition with large slip may indicate either the engine is adequate for the ship, but pitch-ratio too high, or, on the other hand, engine is adequate for propeller, but both too small for ship. In the former case the remedy will be a decrease in pitch-ratio, and in the latter an increase in engine power and in size of propeller.

This same condition with small slip may imply engine adequate for ship, but propeller is of too large diameter, or too much surface, or both.

With the slip lying within the normal working range, this condition may indicate engine adequate for ship, with some combination of too high pitch-ratio, too large diameter and too much area; or, on the other hand, propeller adequate for ship but engine too small. Usually the special conditions will make it possible to discriminate between these double cases.

In all these cases it must be understood that the engine cannot develop the power unless the propeller will allow it to make the revolutions, and any condition which tends to hold the engine down below its designed revolutions will by this very fact tend to prevent the development of the indicated horsepower, and hence the realization of the speed.

(*b*) The revolutions rise above the designed figure, running down the steam pressure, and working off all the steam the boiler will furnish, but without giving the expected speed. In such case nearly the full engine power is developed, but the excessive revolutions will presumably mean a corresponding increase in the slip and a falling off in the efficiency. This will result in a waste of power, and in failure to realize the full speed. The remedy will be a larger propeller, or more surface, or both, in order to hold the revolutions and slip down to values which will give the propeller a chance to apply with good efficiency the power which it receives from the engine.

(*c*) The expected revolutions are obtained, but the speed is low and the slip excessive. This shows that the propeller is absorbing all the power that the engine is developing, but that the efficiency is presumably low, and the total power probably too small for the purpose. Such a result might, for example, be obtained on a large ship with an engine and propeller entirely too small. The remedy means more power at the start and a larger propeller for its economical application. If, however, no more power can be supplied, and it becomes a question of doing the best possible with the power at hand, then some gain can be realized by applying such power as is available with the best possible efficiency, and accepting such reduced speed result. This means a reduction of the slip, and this, in turn, means some combination of the following items: larger diameter, lower pitch-ratio, more surface and perhaps higher revolutions.

The same general relations may also be stated with reference to the results of poor design. First assuming the engine adequate for the ship we have as follows:

(I.) With suitable diameter and pitch-ratio and too little surface, the revolutions and slip will be high, especially at the upper revolutions, and the speed will fall short.

(II.) With suitable diameter and pitch-ratio, but too much surface, the revolutions may fall below the proper value and the engine may fail to develop the full power, and the speed will therefore fall short.

(III.) With suitable diameter and surface, but too high a pitch-ratio, the revolutions will be too low, the engine will not develop the power, and the speed will fall short.

(IV.) With suitable diameter and surface, but too low a pitch-ratio, the revolutions will overrun; the steam pressure will be run down, the engine will not develop the power efficiently, and it may be possible that the slip will fall below the value for the best efficiency; or, on the other hand, it may not be permissible to run the engine at the higher speed. In either case the speed of the ship may suffer in consequence.

(VI.) With suitable pitch-ratio and surface, but too large diameter, the revolutions will overrun with increasing slip, and the steam pressure will be run down, both of which will react unfavorably on the power finally applied on the ship. On the other hand, if the higher revolutions cannot be allowed, then the engine must be held back, the full power will not be developed, and the speed will fall short.

(VI.) With suitable pitch-ratios and surface, but too large diameter, the revolutions will fall short, full power will not be developed, the slip may fall below the value for best results, and the speed will fall short.

(VII.) If, on the other hand, we have the engine adequate for the propeller, but both too small for the ship, the result will be low revolutions and speed and high slip.

(VIII.) Again, if the propeller and ship are properly matched but the engine power is too low, the result will be low revolutions and speed and normal slip.

In actual cases the result will often depend on some combination of the several items. A careful study of these various cases from both points of view as given above should, however, serve to indicate the probable nature of the trouble in any given case, and thus point the way to the changes required for improvement.

(3.) *Number of Blades.*

So far as experience may determine, there seems to be no reason for assuming that the number of blades, in itself, is an item of great importance. Indirectly, the number of blades affects the result by its influence on the amount of surface which can be comfortably carried. There is every reason to believe that between two propellers of the same surface, one of three and one of four blades, all other things being equal, the difference in the performance would hardly be of practical importance. It results actually, however, that the average propeller of four blades will have more area than that of three, and the latter more than that of two. Hence, the use of two, three or four blades is partly a matter of the allowable diameter.

Where the utmost must be realized on a given diameter, four blades should be employed. Where, on the other hand, the available depth will permit a diameter suited to the area readily carried by three blades, the three-bladed propeller will usually be preferred on account of the decreased cost of construction as compared with that of four blades, especially with removable blades. The two-bladed propeller, in modern practice, is confined to the reversible types, such as are fitted with gas engines and runabout boats, launches and small yachts. With twin or multiple screws the draft usually admits readily of the three-bladed form, and such are commonly employed in such cases.

(4.) *Shape of the Blade.*

Prevailing practice based on the sound interpretation of experience justifies the use of a generally oval, or possibly pear-shaped developed form of blade. The usual types are oval, and often elliptical, or nearly so, as discussed in Part II. There seems to be no objection, however, to filling out the blade somewhat toward the tip, especially if it is left well rounded, thus giving it a form slightly tending toward the pear shape, with broad end at the tip. In particular it is desirable to avoid sharp angles and corners at the tips, as such are sure to produce eddies in the water with an accompanying loss of efficiency.

(5.) *Amount of Surface.*

The amount of surface has been already referred to in the chapter on Design. Supplementing the brief reference there made, it will be sufficient to note that in general, variation of area affects efficiency very slowly; that increase of area brings with it increase of thrust and greater general effect, but at a slower and slower rate as the area is added, until a point is ultimately reached beyond which increase of area gives no addition of thrust, and may, indeed, result in a loss of thrust and general effect; that this condition is reached at lower and lower limits the lower the pitch-ratio; that this limit will be found somewhere about .55 or .60 area-ratio for high pitch-ratios, and not far from .40 for fairly low pitch-ratios, with corresponding intermediate limits for intermediate values of the pitch-ratio; that while this limit will vary somewhat with the shape of blade and thickness, these general limits may be accepted as giving substantially all the thrust likely to be obtained without danger of loss in efficiency.

(6.) *Specially Low Pitch-Ratios.*

There has recently arisen special interest in the use of very low pitch-ratios for gasoline motor boats and in connection with the steam turbine. Such relatively small experimental data as is available seems to indicate that such pitch-ratios may be employed with fair efficiency, provided too much surface is not employed. With excessive surface the efficiency is sure to be very low indeed, with resultant loss of useful effect. The upper limit of surface area for propellers of pitch-ratio less than unity should presumably be not much over .35.

(7.) *Immersion of the Propeller.*

With insufficient immersion of the blades, and in particular if the blades cut the surface of the water, air will be drawn down and mixed with the water operated on so that the actual material handled by the propeller will be not water, but an emulsion or mixture of air and water. This of course weighs less per cubic foot than water alone, and in consequence the thrust gained by the propeller when operating at a given slip will be decreased, with corresponding loss in effect. In general, therefore, the immersion of air. The necessary depth of immersion will increase with the of the blades should be sufficient to insure against such indraught slip at which the propeller works. For ordinary conditions the tip of the blade in its highest position should not come nearer the surface of the water than about ¾ the radius, though with moderate values of the slip smaller immersions may be safely employed. It should be noted that with the proper design in advance, the blades may be allowed to cut the surface of the water without sacrifice to propeller. It will simply call for a larger propeller—sufficiently large so that, working on the mixture of air and water, it may nevertheless obtain the needed thrust at a moderate value of the slip. Such propellers have been sometimes employed in connection with canal-boat propulsion.

(8.) *Location of Propeller Relative to Ship.*

In a general way, the propeller should be kept well clear of the stern post in order to avoid the sharp blow which may be communicated from the blade to the ship when the clearance is small, especially at high speeds. Beyond this, the farther the propeller is away from the ship, the less will be the effect of its "suction" on the ship, producing the virtual increase of resistance. On the other hand, if placed too far away, some effect may be lost by way of the wake in which the propeller works, and which returns through the propeller some part of the energy which has been spent in producing it by the motion of the ship through the water. Having in view structural and general considerations, it will usually be found desirable to set the propeller as near the ship as may be permitted by the considerations of clearance just noted.

(9.) *Number of Propellers.*

This question is one turning chiefly on the desired subdivision of power, the available draft and the desired number of revolutions of the engines. There seems to be no reason for believing that in themselves two or three or more propellers are more or less efficient than one. In each case, however, the propeller must be adapted to the conditions under which it is to work. In general, the greater the number of propellers and the less the power of each one, the smaller the propeller and shaft, the less the draft in which it can work, and the higher the revolutions for a given speed.

(10.) *Cavitation.*

This is the name which has been given to a condition which has arisen in connection with very high speeds. It is found that, beyond a certain speed and under certain conditions, the water does not close in behind the propeller blades, and that, in consequence, they work, to a greater or less extent, in the cavity thus formed within the water. This results in a decreased thrust and general loss of effect. It has been found that by a suitable provision of blade surface in proportion to the thrust this condition may be avoided. The necessary surface may be determined closely by the following equation:

$$A = \frac{D^{\frac{2}{3}}u^2}{8}$$

where A = projected area of all blades in square inches,
D = displacement in tons, u = speed in knots.

It will be noted that this is the projected area and not the actual or developed, and that it must be determined by laying the propeller blade down on the drawing board and measuring the resulting projected area.

Thus for illustration, if $D = 216$ and $u = 25$, then projected area not less than $\frac{216^{\frac{2}{3}} \times 25^2}{8} = \frac{36 \times 625}{8} = 2813$ square inches, should be employed.

(11.) *Dock Trials.*

It is a fact not always remembered that with the vessel tied to a dock the engine cannot develop the full power. This is because the propeller will hold the revolutions down and prevent the realization of the designed engine speed, and hence the development of the designed power. The explanation of this effect on the revolutions is found in the fact that with the vessel tied to the dock the slip is 100 percent, and hence the full thrust and full turning moment are reached at a lower value of the revolutions than when the vessel is in free route, and the propeller is operating at the normal slip. Now the revolutions at which an engine will run are determined by the condition when the resistance to turning the propeller will just balance the turning moment of the engine. In other words, the engine will run up to the speed at which the resistance to turning the propeller will just balance the turning moment furnished by the engine. The latter, with any given engine, is primarily dependent on the steam pressure, and hence with fixed pressure the moment remains fixed. Now there is a close and practically fixed relation between the thrust developed by the propeller and the effort required to turn it, so that, with a fixed maximum turning moment, we shall have very closely a fixed maximum thrust. Both of these furthermore depend on revolutions and slip; the higher the revolutions the lower the slip at which a given thrust and turning moment will be developed, while, *vice versa,* the higher the slip the lower the revolutions at which a given thrust and turning moment will be developed. It immediately follows, then, that if a propeller is operating under excessive slip, the maximum thrust and the turning resistance which will balance the engine moment will be reached at lower revolutions than with normal slip, and when this condition is reached, the revolutions can, of course, go no higher without a further increase in steam pressure and in the moment developed by the engine. Due to these facts, no engine can develop full power under dock trial, and the results of such trial must, therefore, not be taken as representing the power capacity of the engine.

(12.) *Power Developed when Towing.*

For similar reasons, when one ship is towing another the full power cannot be developed. The propeller, when towing, will necessarily work at a higher slip than when the ship is running free, and hence will reach the full thrust and full turning moment at lower revolutions, and hence at lower power, even with full steam pressure. See also (2) Case VII.

(13.) *Action of the Propeller in Stopping and Starting.*

The principles stated with reference to the action of the propeller in towing or in dock trials will serve to make clear its action in stopping and starting. In the latter operation, suppose the full steam pressure thrown on the engine. This means the full engine turning moment, and, in answer, the propeller will rapidly jump up to the speed at which the full thrust and turning moment will be in equilibrium with the engine, and each will remain substantially unchanged so long as the steam pressure remains the same. This condition will, furthermore, be reached at revolutions somewhat below the maximum number, and for the same reason as in a dock trial—simply because the slip is excessive and the full moment is reached with excessive slip at a lower value of the revolutions than when the slip has its normal value. The full thrust thus developed is, of course, all available for starting the ship from rest; but, as the speed gradually increases the water resistance correspondingly increases and absorbs a correspondingly larger part of the thrust, leaving a smaller and smaller part available for increasing the speed of the ship. It thus results that the gain in speed, at first large, grows less and less as the ship finally approaches her top speed, when the water resistance will absorb the full thrust, with nothing left over for gain in speed. As the ship gathers headway, moreover, the slip, at first large, will grow less and less, and the revolutions at which the full thrust and turning moment are developed will become higher and higher. The revolutions of the engine will, therefore, increase gradually as the speed increases, coupled with a corresponding increase in power; all at a constant steam pressure, turning moment, and substantially constant thrust on the ship. In this manner the ship gathers headway, and finally reaches her top speed, at which we have the maximum revolutions and power, with the full thrust balanced against the water resistance of the ship.

Conversely, in stopping the ship the propeller develops a backward pull on the shaft, which opposes the forward motion of the ship. At the first instant of backing, therefore, the forward motion is opposed both by the water resistance and by the pull of the propeller. As the ship slows down under the combined action of these retarding forces, the water resistance becomes less and less as an opposing force, and the total retarding force approaches more and more nearly to the backward pull of the propeller. It thus results that the retardation, at first pronounced, gradually decreases until the ship is finally brought to rest under the retarding influence of the propeller alone.

(14.) *Measurement of Pitch.*

To determine the pitch of a given propeller three measurements are necessary. See figure 38. These are:

(1.) The radius OA at which the pitch is desired.

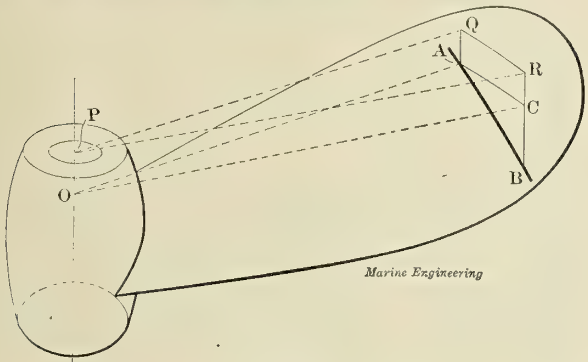


FIG. 38.

(2.) The angle or part of the complete circumference corresponding to the distance on the blade between A and B, the two points between which the pitch is to be found.

(3.) The advance BC parallel to the line of the shaft, corresponding to this part of a complete revolution.

In the figure, A and B are points on the face of the blade and are at a constant distance OA from the shaft center-line OO. AC is an arc of a circle which lies in a plane through A and perpendicular to the shaft. The angle AOC is, therefore, the one referred to in (2), and the distance BC is the corresponding advance. Then BC is the same fraction of the entire pitch that AOC is of the complete circle, or the same fraction that the arc AC is of a complete circumference with OA as radius. This complete circumference will be $6.2832 \times OA$. Hence the proportion:

$$AC : 6.2832 \times OA :: BC : \text{pitch}.$$

$$\text{or pitch} = \frac{6.2832 \times OA \times BC}{AC}.$$

It is not, however, so easy to measure AC as AB, so that we may put for AC its equal $\sqrt{AB^2 - BC^2}$ and we then have:

$$\text{pitch} = \frac{6.2832 \times OA \times BC}{\sqrt{AB^2 - BC^2}}.$$

A brief outline of the operations is as follows:

(1.) Select the points A and B at and between which the pitch is desired, making sure that they are at equal distances from the shaft center line. This can be done by squaring down from a straight edge or other reference line PQ, PR, placed across the hub at right angles with the shaft. Then measure the length AB.

(2.) The propeller being leveled up, measure the distance BC from a level through A vertically down to B. Or if the propeller cannot be leveled, measure from B in a direction parallel to the shaft, out to a line through A in a plane at right angles to the shaft. Or measure from Q down to A and from R down to B and take their difference BC.

(3.) Multiply the distance OA or its equal PQ by 6.2832, and by the length BC, all in the same units of measure.

(4.) Square the lengths AB and BC, subtract the square of the latter from that of the former, and extract the square root of the difference.

(5.) Divide the result found in (3) by that found in (4), and the quotient will be the pitch desired.

Thus, for example, suppose

$AB = 20$ inches, $BC = 13$ inches and $OA = 48$ inches.

Then $6.2832 \times 48 \times 13 = 3920.7$.

Also $\sqrt{400 - 169} = \sqrt{231} = 15.2$.

Then $3920.7 \div 15.2 = 238$ inches $= 21$ feet 6 inches $=$ pitch.

If the pitch is variable instead of uniform, the operation is precisely the same, but the result found must be considered merely as the mean or average value of the pitch between the points A and B. For other parts of the blade a similar process will give the pitch at those points.

When the propeller is in place on the ship it is sometimes more convenient to carry out the principles involved in this method of measuring pitch somewhat differently, as follows: Let the propeller be turned so as to bring one of the blades horizontal. Then select the place at which the pitch is desired, and hang over the blade at this point a cord with two weights, as shown in figure 39. Care must be taken that the two points A and B at

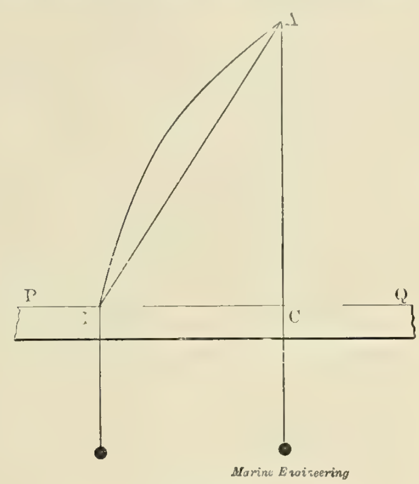


FIG. 39.

which the cord touches the edges of the blade are at the same distance from the center. It is then readily seen that the points A and B of figure 38 correspond to the similar points of figure 39, except that in figure 39 they are of necessity taken on the extreme edges of the blade. We then level up a bar PQ and measure the distances, AB and BC, as noted above, using them in the same way for finding the pitch. Or we may measure AC directly and use this with BC in the proportion above.

As a rough and ready rule, it may be remembered that the pitch of a propeller will equal the length of a circumference at the place on the blade where the slope of the face is 45°. At this point let the radius be r. Then pitch $= 2\pi r = 6.2832\, r$. In this way an approximate idea may often be quickly obtained of the pitch of a wheel by estimate without special measurement, except for the radius or diameter at which the blade has the slope of 45°.

The details of the above methods for finding pitch may vary considerably, but the description given will serve to show the principles involved, and with reasonable mechanical skill no trouble will be found in carrying out the measurements required.

(15.) *Thrust on Propeller.*

It is frequently desired to ascertain the thrust under which a given propeller is working. To this end if the indicated horsepower and speed are known, we may use the following formula, which will be found sufficiently exact for most practical purposes:

$$T = \frac{220H}{u}.$$

Where T = thrust in pounds, H = indicated horsepower,
u = speed in knots.

Thus, for example, if $H = 1200$ and $u = 15$, we have

$$T = 220 \times 1200 \div 15 = 17{,}600 \text{ pounds}.$$

If, on the other hand, we have the displacement and speed, we may use the formula:

$$T = \frac{220 D^{\frac{2}{3}} u^2}{K}.$$

Where T = thrust in pounds, D = displacement in tons,
u = speed in knots, and K = Admiralty coefficient as discussed in the chapter on Design in connection with the factor a.

Thus, if $D = 512$, $u = 20$, $K = 240$,

$$T = 220 \times 64 \times 400 \div 240 = 23{,}467.$$

Since, moreover, the value of K is often about 220, more or less, it will often happen that the product $D^{\frac{2}{3}}\ u^2$ by itself will furnish a first approximation to the value, and sufficiently exact for an immediate purpose or where only the general character of the result is desired.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, report under date of March 10, 1905, the following percentage of completion of vessels building for the United States Navy:

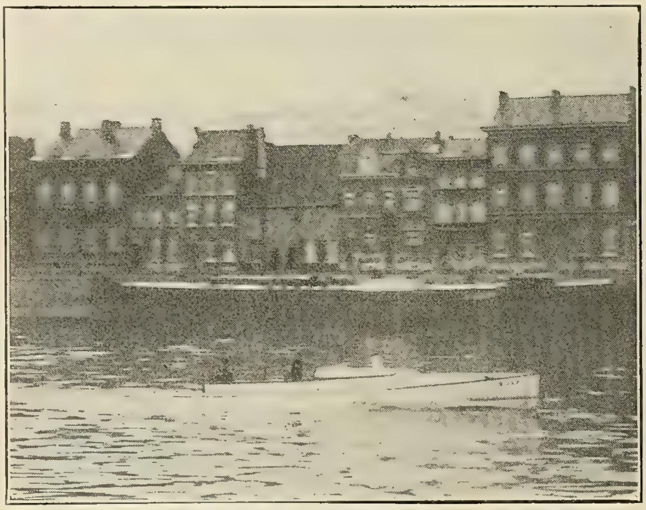
			Feb. 1.	Mar. 1.
BATTLESHIPS.				
Virginia	19 knots.	Newport News Co	76.96	80.82
Nebraska	19 "	Moran Brothers Co	65.8	67.59
Georgia	19 "	Bath Iron Works	73.61	75.09
New Jersey	19 "	Fore River Shipbuilding Co	75.7	77.9
Rhode Island	19 "	Fore River Shipbuilding Co	80.7	82.5
Connecticut	18 "	Navy Yard, New York, N. Y.	64.51	67.17
Louisiana	18 "	Newport News Co	67.8	69.54
Vermont	18 "	Fore River Shipbuilding Co	35.4	38.8
Kansas	18 "	New York Shipbuilding Co	41.3	43.5
Minnesota	18 "	Newport News Co	55.7	58.69
Mississippi	17 "	Wm. Cramp and Sons	20.6	22.55
Idaho	17 "	Wm. Cramp and Sons	18.09	19.98
New Hampshire	18 "	New York Shipbuilding Co	0.0	0.0
ARMORED CRUISERS.				
West Virginia	22 knots.	Newport News Co.	99.25	99.75
California	22 "	Union Iron Works	70.	72.2
Maryland	22 "	Newport News Co	96.5	97.5
South Dakota	22 "	Union Iron Works	67.9	69.5
Tennessee.	22 "	William Cramp and Sons	63.13	65.14
Washington	22 "	New York Shipbuilding Co	62.7	66.4
North Carolina	22 "	Newport News Co	0.0	0.53
Montana	22 "	Newport News Co	0.0	0.55
SEMI-ARMORED CRUISERS.				
St. Louis	22 knots.	Neafie and Levy Co	58.5	58.8
Milwaukee	22 "	Union Iron Works	66.7	68.
Charleston	22 "	Newport News Co.	90.22	92.02
PROTECTED CRUISERS.				
Chattanooga	16½ kts.	Lewis Nixon	99.13	99.13
Galveston	16½ "	Wm. R. Trigg Co	96.	98.
GUNBOATS.				
Dubuque	12 knots.	Gas Engine and Power Co	85.7	88.2
Paducah	12 "	Gas Engine and Power Co	76.2	78.6
TRAINING SHIPS.				
Cumberland	Sails	Navy Yard, Boston	91.	94.
Intrepid.	"	Navy Yard, Mare Island	78.	86.
TRAINING BRIG.				
Boxer	Sails	Navy Yard, Portsmouth	97.	98.
TORPEDO BOATS.				
Stringham	30 knots.	Harlan and Hollingsworth	99.	99.
Goldsborough	30 "	Wolff and Zwicker	99.	99.
Nicholson	26 "	Lewis Nixon	99.	99.
O'Brien	26 "	Lewis Nixon	99.	99.

THE AUTOMOBILE BOAT HILDA.

BY L. RAMAKERS.

The John Cockerill Company has just built, in its naval works at Anvers, an interesting automobile boat designed for use in the study of the application of internal combustion motors to the propulsion of rapid boats. Although this boat should be classed, on account of the power of its engine, in the category of racers, it is distinguished from these by the fact that not everything has been sacrificed to speed; the hull, very strong, is constructed of steel; the motor, also strong in every part, turns at the relatively low rate of revolution of 900 per minute. In fact the boat is not a racer, but is simply a very rapid cruiser.

The hull measures 9.45 meters (31 feet) in length; 1.20 meters (3 feet 11.2 inches) in beam, and 0.61 meters (24 inches) in depth. The shell, which is constructed of sheet steel, is supported by frames of steel angles spaced 50 centimeters (19.7 inches) apart. There are three water-tight bulkheads, which renders the boat absolutely unsinkable, even in case of the destruction of the bow in collision, for the first water-tight bulkhead, called the collision bulkhead, would limit to a very small quantity the volume of water introduced. The gasoline reservoir, made of galvanized sheet steel, is riveted and brazed. It is placed between two water-tight bulkheads, which renders a disastrous fire practically impossible.

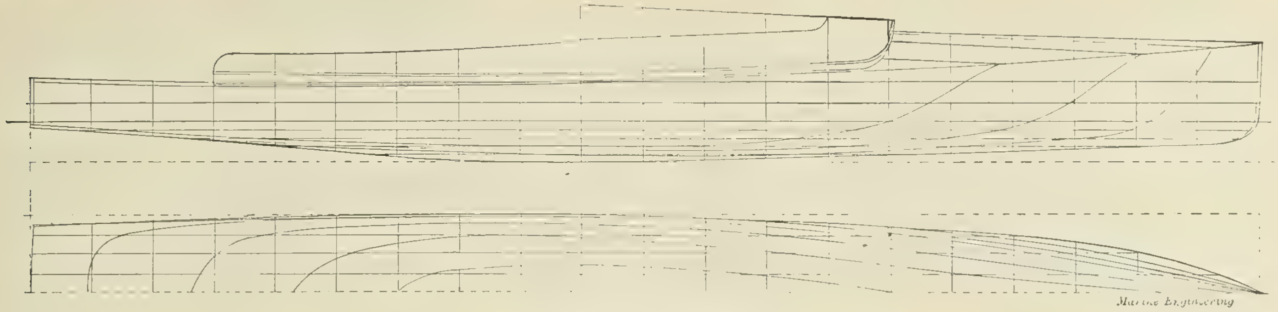


THE HILDA AT FULL SPEED.

The motors, accumulators, and all of the mechanical organs are completely sheltered under an aluminum hood, which may be dismounted in a few seconds, or put in place simply by means of two nuts of simple and rapid action. The exhaust pipe is led under the base of a large funnel which projects above the hood. The discharge of the burnt gas produces in this funnel a violent current of air, the effect of which is to continually clear the hood of the fumes produced by the motor, to restrict an increase in the temperature, and to prevent the accumulation of an explosive gas from the accidental leakage of the carburetor or from a leakage of the gasoline pipes. In fact, the gas is diluted to such an extent by air, that the odor, at worst very slight, disappears completely.

Those who, in order to cool their motors, have employed coils of pipe, will recognize the fact that this disposition of the funnel has a very practical value, the inconvenience arising from the former practice being especially the introduction with the air for combustion of a certain amount of water whenever the sea is at all rough, and, in addition, the drawing down upon the pilot of all the fumes and odors from the motor.

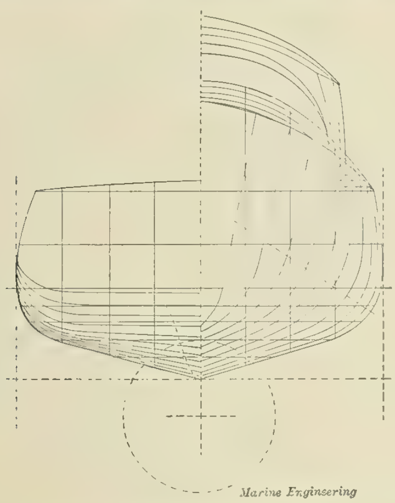
The plans which we publish show much better than could a long description the disposition of the machinery on board. The plan of the lines of the boat is of considerable interest because of the excellent results given on trial. As may be seen, the water-lines are



THE LINES OF THE HILDA.

decidedly straight forward, while the stern is completely flat, this being in contrast with the general practice of boat builders on the continent.

The engine is of the Standard type, 35 horsepower, and was built by the Germain Company at Charleroi, Belgium. It has four cylinders, with suction valves so controlled as to permit a variable rise of valve, thus allowing the motor to run constantly at a prearranged speed anywhere from 180 to 900 revolutions per minute, without having to regulate through the carburetor. The



THE BODY PLAN.

reversal of direction is made by means of a differential gear, the operation of which gives complete satisfaction. The screw is of a simple form, with a diameter of 50 centimeters (19.7 inches), and a constant pitch of 66 centimeters (26 inches). The generatrix is right-handed and inclined toward the rear at an angle of 78 degrees. The material is bronze.

The results given at the trial of this boat upon the river Meuse, at Liège, in calm weather, are as follows:

Load, three men and 68 kilograms (150 pounds) of gasoline.

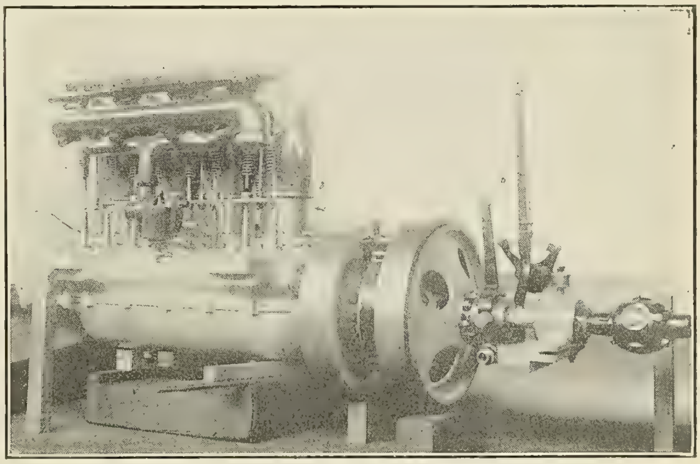
Total displacement, 1,604 kilograms (3,530 pounds).

Freeboard amidships, 27 centimeters (10.6 inches).

Horsepower of engine as given by a trial in the shops, 45, at 900 R. P. M.

Speed upon an officially measured course of 3,530 meters (3,860 yards), as shown by means of the time required to cover the course: against the current, 405 4-5 seconds, giving a speed of 31.35 kilometers (16.9 knots) per hour; with the current, 395 seconds; speed, 32.2 kilometers (17.33 knots) per hour.

Absolute mean speed, 31.77 kilometers per hour, or 17.11 knots.



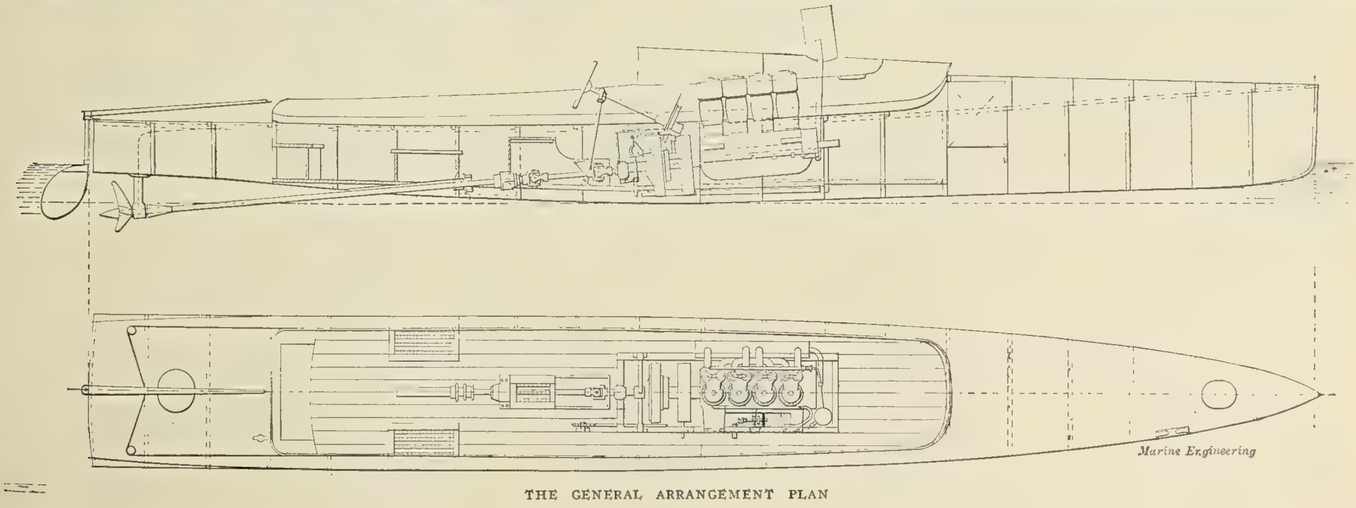
THE FOUR-CYLINDER ENGINE AND GEAR.

Revolutions per minute, 906.

From these figures it is possible to deduce certain coefficients, one of which is the slip of the screw, which figures out at 11.5 percent. Another coefficient of performance, according to a French formula, and based on the assumption that the maximum of 45 horsepower was actually attained on trial, is as follows:

$$M = \sqrt[3]{\frac{B^2 V^3}{F}} = \sqrt[3]{\frac{0.27 \times (17.11)^3}{45}} = 3.11.$$

These results are remarkable, particularly in view of the fact



THE GENERAL ARRANGEMENT PLAN

that, according to a well-authenticated article on automobile boats appearing in 1904, in *le Bulletin de l'Association Technique Maritime,* this has never before been obtained by a boat of this type, not even by the celebrated French boats *Lutèce* and *Rapée III.*

These results are due in a large measure to the splendid form of the hull. At high speed, this hull raises itself forward and appears to glide over the water, producing at the stern a very slight wake. For several months the boat has been operating at full speed upon the narrow and crowded Meuse at Liège, without having provoked the slightest objections from the boatmen on account of any swell set up. The photograph of the boat at full speed, which we publish, will show this remarkable absence of wake.

The boat, covered with its hood, has shown itself to be a very good sea boat, even in rough water, while its stability is considerable. It has often carried as many as seven people, under which circumstances the speed has been reduced to 29 kilometers (15.6 knots) per hour. The rudder, in spite of its small dimensions, allows the boat to turn very sharply; at full speed the boat can easily turn around upon the Meuse at a place where the width is not greater than 100 meters (109 yards). In spite of the almost continuous and excessively hard service to which the boat has been subjected since last August, neither the hull, nor the engine foundations, nor the motor itself give the slightest trace of fatigue. This is the incontestible advantage accruing from a steel hull, particularly when fitted with a powerful engine.

Talks on Lubrication on Marine Engines.

Noon-hour talks over the dinner pail concerning the technicalities of engineering, mechanics, machine fittings, etc., are getting to be quite common. The other day the subject drifted along the lines of lubrication of bearings of marine engines, and the older and more experienced men gave us a few points on looking out for troubles, that were good. The spokesman made hand-chalked sketches on the shop floor, and some I believe are good enough to reproduce. The first sketch shows the necessity of keeping a cover on a bearing. It represents a shaft without a bearing, which is supplied with a means for being turned at about 100 revolutions per minute by the belt *C*. There is an oil-delivery tube at *A*, and drops of oil are deposited upon the turning shaft as shown. The movement of the surface of the shaft carries the films of oil along for a short way, but the centrifugal force is such that the oil flys off the surface at *B*. If, however, as in practice, there is a cover provided, this oil does not escape, but is confined close to the shaft.

Of course there are conditions that come in to make the parts heat and bind even when free lubrication is provided, as in Fig. 2. Here we show an unevenly worn journal (in exaggerated proportions), which wear is partly rectified by the insertion of specially-fitted sleeves or parts of sleeves, like *D*. The tapered condition of sleeves that are inserted like this often results in binding and increased friction, squeaking, and groaning. Sometimes one finds that the sleeve binding is out of line and that there are gaps, as at *E*. In the open space at right of the journal is given opportunity for oil and metal dust, flyings, waste, etc., to gather and gradually work into the lubricant and cause heating and binding in the bearing.

Then, again, I have run across bearings in which even the best grades of oil cannot keep the temperature down, and prevent squeaking. This was due entirely to the dropping of one end of the shaft in the worn journal, as represented in Fig. 3. This sketch shows the gaps at *F* and *G*, caused by the worn parts in the sleeves. New sleeves will overcome this trouble; but oftentimes the defect is allowed to run and the heating blamed to the grade of oil used.

The clogging of oil channels is often a source of trouble with journals. The channels get clogged by the oil drying and fine particles of dust collecting. I have seen several cases in which complaints were made of the undue heating of journals of very good engines, while upon examination the oil holes were found completely clogged. In one instance the parties purchasing a new engine for a yacht complained to the builders that the machine was running hot. An investigation proved that a poor grade of oil was used, and that the oil holes of the heated parts were nearly closed by the congealed oil, so that hardly a drop of the quantities of oil squirted over the caps, the machinery, and engine space reached the bearing surface; Fig. 4 shows the simple cause. The

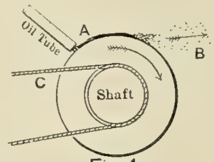
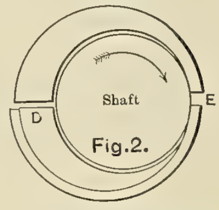


Fig. 1.



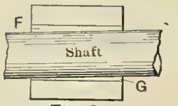


Fig. 3.

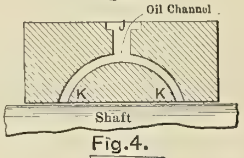


Fig. 4.

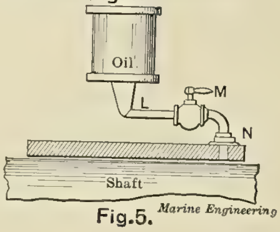


Fig. 5. *Marine Engineering*

oil feeds were through a channel with double ends, as at *K, K,* the feed being at *J*. The cheap lubricants refused to make these channels and collected in the neck, choking the passage, and thereafter the bulk of the oil with which the oiler drowned the parts simply flowed to the deck. We first soaked the journal and parts in lye water, to remove all gummed matter, then a proper adjustment of feed was made with the right grade of oil, and the bearings never heated again.

Fig. 5 is a drawing of a common form of oil feed employed in marine service, which often gives trouble. The reason is that the elbow *L* is too cramped and the oil passage readily chokes up, particularly when heavy oils are run. The valve at *M* ought to be examined to see if the passage is free. I have frequently found new valves leak at the very beginning, thus wasting the oil. In this form of feed the inlet to the bearing is sometimes at *N*, while the other end of the bearing is neglected. If these bearings are taken apart, nine times out of ten more oil will be found at the delivery side than the other. Often the discrimination is such that the side not supplied with oil is almost dry, and trouble results. It is a good plan to insert the feed tube in the center or have a tube for each end. "Ex-Machinist."

On page 125 of our March number was published a photograph of the new armored cruiser *Maryland,* taken by Mr. N. L. Stebbins, of Boston, during the trial trip of the ship, and copyrighted by him. Through an oversight due credit was not given Mr. Stebbins for this photograph, and we desire here to rectify the error.

Oil Fuel as Compared with Coal.

The many advantages of oil fuel on shipboard as compared with coal have frequently been mentioned in these columns, such as decreased weight, stowage in water bottom whereby bunker space is available for cargo, ease of loading, decrease in boiler-room force and expense of up-keep, etc. One important point—the facility of control whereby a high steam pressure may be maintained practically constant—is strikingly shown by a comparison of the two diagrams here presented, taken by a recording-pressure gauge on the steamer *Arizonan*, of the American Hawaiian Steamship Company.

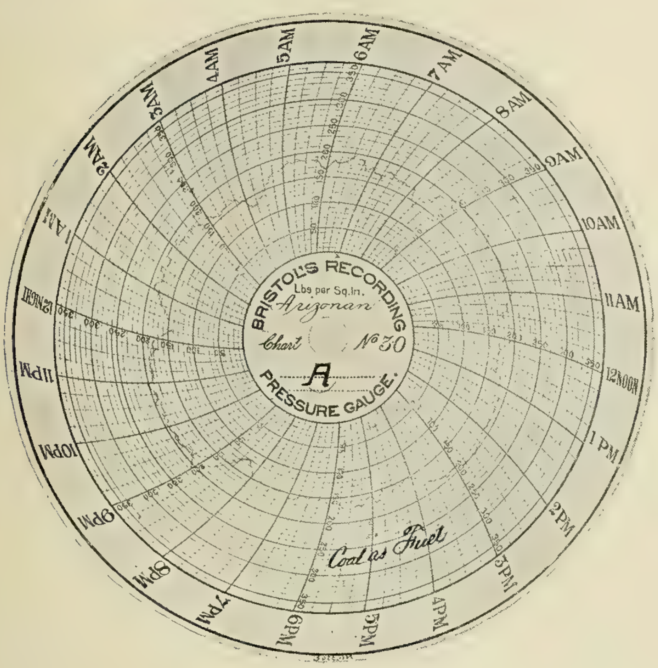
Each chart is a record for twenty-four hours while the ship was at sea. The one marked *A* was taken on a voyage from San Francisco to New York when coal was burned in the boilers. So successful had been the results of the oil-burning apparatus on board the *Nebraskan*, another vessel of this fleet, that a few months ago the *Arizonan* was fitted with the Lässoe-Lovekin system, and on January 9, 1905, completed her first round trip from San Diego to New York and return with oil as fuel. It was on this voyage that chart *B* was made. On both charts the pencil of the gauge records 15 pounds above the actual.

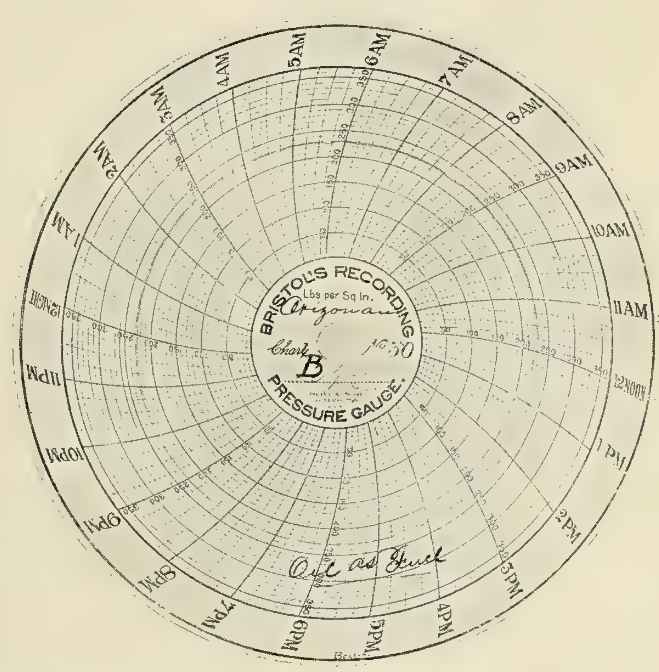
constant steam pressure are recognized by any engineer; not only will less attention be needed in adjusting and running the main engines but the auxiliaries, such as the boiler feed pumps, etc., will naturally run at constant speed under uniform steam pressure.

The boilers themselves will require less repairs where oil is used, as the furnaces, back connections and tubes are subjected to practically the same temperature every hour of the day. As the oil combustion is complete no soot is deposited and the heating surfaces are clean and thus at their maximum efficiency for transmitting the heat. Where coal is used, each time the furnace door is opened a draft of cold air enters, striking the plates, and thus subjecting them to strains due to unequal temperature.

These practical and other economic advantages resulting from the installation of oil-burning equipment have been decidedly proven on four steamers of this company. The boiler dimensions of the *Arizonan*, a sister ship of the *Nebraskan*, and the data of her recent voyage from New York to San Diego are given as follows:

Number of boilers	3
Length inside heads	10 ft. 2 ins.





The steam pressure when coal was burned did not exceed 185 pounds, while it dropped when cleaning fires as low as 105 pounds at 8:30 P.M. In fact, the drop at the beginning of each watch, when the fires were cleaned, is most noticeable, as well as the variations during watches. In contrast to this, with oil fuel, the pressure was maintained at 215 pounds throughout the day.

A word of explanation should here be given as to the cause of the great drop when burning coal. The *Arizonan* has scant boiler power, and with coal the boilers were at all times forced to their limit to supply steam, so that as soon as a fire was drawn, which means that that furnace was temporarily out of service, the steam went down at once. To have maintained, when burning coal, the same steam pressure as when oil was used, would have required fitting another boiler; thus with oil fuel the capacity of a boiler plant is increased about one-third, or a given power may be attained on 25 percent fewer boilers.

Another most important advantage resulting from the use of the oil-burning apparatus is the increased steam pressure; with coal the maximum was about 200 pounds, while with oil it is maintained uniformly at 215 pounds. The actual results on this ship meant an increase in speed of one knot—from 9 to 10 knots. The improved running of the main and auxiliary machinery due to

Diameter inside	14 ft. 3 ins.
Furnaces each	4
Combustion chambers, each	2
Furnaces, diameter inside	34 ins.
Grate surface as first fitted, bars, 4 feet 6 inches each	54 sq. ft.
Heating surface, each	2,040 sq. ft.
H. S. ÷ G. S.	37.7
Calorimeter area	9.8 sq. ft.
H. S. 3 boilers	6,120 sq. ft.
Draft average for voyage	26 ft. 8 3-4 ins.
Displacement for voyage	16,000 tons
Steaming time, 53 days, 11 hours, 52 minutes.	
Distance run	12,773 miles
Speed average	9.94 knots
Slip of screw	20.3 percent
I. H. P. main engines	2,700
I. H. P. total	2,900
Oil used, Texas reduced	13,418 bbls.
Average consumption oil per hour	10.45 bbl.
Average consumption oil per I. H. P. hour	1.17 lbs.

The oil consumed was measured by meter at a temperature of 100 degrees Fahrenheit. "F. D. H."

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The New York Motor Boat Show.

With the great resources of Madison Square Garden taxed to the limit by the hundreds of exhibits, the National Motor Boat and Sportmen's Show of 1905 was opened on the evening of February 21st and closed just before midnight on the 8th of March. By a gradual process of evolution, a sportsmen's show, with motor boat annex, has now become in effect a motor boat show, with the sportsmen as auxiliaries. The rapid progress and development in the design of internal combustion motors, together with the concurrent introduction of innovations in the forms of hulls, renders such an exhibition of great value to the student of the subject and to the engineer; while the opportunity afforded intending purchasers to see under one roof such a great variety of types and makes, of sizes and styles, not only aids them in making a satisfactory choice, but arouses in many cases such an interest in the subject among those who attend the show as mere onlookers as to procure other purchasers from this class, and thus extend the general scope of the business among the purchasing public. As a financial venture, therefore, the annual exhibition is regarded as a success, and exhibitors feel well repaid for the great expenses and labor incident to its inception and realization.

The possibilities afforded by the artificial lagoon to demonstrate the qualities of certain of the boats and motors under exhibit are of very necessity curtailed by the rigid limitations in the size of this body of water. It does constitute, nevertheless, a most useful adjunct to the show, and the numerous boats floating upon its surface, and occasionally making a circuit of the central island, offer valuable information to the observer of the operation and control of both engines and boats. The necessarily frequent stopping and turning, with an occasional backing movement, demonstrate clearly the maneuvering qualities of the boats under operation, and form a splendid opportunity to observe their behavior under a variety of conditions.

Altogether, the show may be said to have been a huge success. Thousands of visitors were accommodated; thousands of dollars' worth of business was transacted, not only between the exhibitors and the public, but among and between the manufacturers themselves; while the prospective business, not actually concluded during the show, has amounted to thousands of dollars more.

A New Era in Steam Navigation.

With the recent arrival of the Cunarder *Caronia,* and the completion of the maiden voyage of the Allan Line steamer *Victorian,* a new era in the history of transatlantic steam navigation may be said to have opened. The *Caronia* marks the transition from the old to the new, not from being essentially different from preceding ships, which she is not, but because of the fact that she is one of a pair of ships, and that her sister, the *Carmania,* whose first trip it is expected will be made early next fall, will be one of the new type, in so far as her method of propulsion is concerned, that is to say, in the main point of divergence between the two types. The hulls of these two ships are as nearly as may be identical in form, though that of the *Carmania* is considerably "fined" aft to admit of the substitution of the three turbine-propelled screws in place of the usual two propellers actuated by reciprocating engines, as fitted in her sister. The designed power being the same, these two ships will afford a most excellent basis for an exhaustive and instructive comparison between the two forms of propulsion, upon so large a scale as to be of the utmost value to the Cunard Company itself, and to the engineering world in general. Followed, as they are shortly to be, by the two mammoth flyers which this company has under construction, it is seen that a very large wedge has been inserted into the future field of steam propulsion.

The Allan Line steamer *Victorian* is to be followed at an early date by her sister *Virginian,* of similar size and power, which is already in the water. Both ships are fitted with steam turbines, and are expected to reduce the time from Liverpool to Montreal by nearly an entire day, as compared with the present running schedule. While not affording the same sort of a basis for comparison as with the two new Cunarders, there will be presented a splendid opportunity for observation, and for the compilation of an immense amount of such data as will be useful for constructive purposes in subsequent designs.

While recognizing the utter futility of discounting the future, particularly in the matter of engineering progress, and in these exceedingly inventive and strenuous days, it may yet be said to be highly improbable that any innovation in marine propulsion will ever rival, in far-reaching effects, the introduction of steam as a propelling agent. Comparable, however, with the general substitution of screw propellers for the older paddle wheels, with the successive economies resulting from the displacement as a constructive material of wood by iron and of iron by steel, the possibilites opened up by the advent of the steam turbine are little short of marvelous, when viewed from the standpoint of the marine engineering practice of a decade since. On the side of the engineer, the turbine effects a remarkable saving in the weight required and in the space occupied for a given power; for continuous running at or near its designed capacity it offers a very considerable economy of operative expenses chargeable to fuel, while under all conditions a large economy ensues in the matter of attendance; the high rate of revolution of the turbine and its propeller makes possible the utilization of a small diameter in the latter, thus effecting at one and the same time an economy in weight and a sufficient submergence beneath the surface of the sea to furnish reasonable security against any such thing as "racing," while the mass of the turbine itself, acting virtually as a fly wheel, would operate as an additional damper upon any tendency of the apparatus to run away. From the viewpoint of the naval architect we have the possibilities of the installation of increased cabin accommodations on account of the decrease in space occupied by machinery. The military naval engineer is interested in the fact that the essential construction of the turbine is such as to place the entire engine close around the shaft, increasing stability and greatly decreasing the head-room required, and thus placing the prime mover far enough below the water-line to be amply safe against the fire of an enemy at sea. Lastly, the passenger on the ship fitted with the turbine method of propulsion is given the novelty of a passage nearly or entirely free from the vibration always a feature of heavy reciprocating engines, however well balanced they may be.

Looking a little into the future, it appears more than probable that the gasoline engine, which has been making enormous strides in adaptability and reliability during the past five or six years, due largely at first to its ultilization as an agent of operation for automobiles, and later quite as much to its rapid introduction as a propelling device for pleasure craft of all descriptions, but more particularly those of small size, will become more and more available for larger powers than those for which it is now usually fitted; will perhaps gradually displace the steam engine for vessels making commercial trips of no great length, such as fishing and coasting craft, river boats carrying both passengers and freight, and possibly some of the smaller types of ocean steamers. Nothing at present in sight would appear to justify the assertion, however, that it will soon become available for the larger class of vessels.

Another form of installation now attracting considerable attention from engineeers is that of producer plants in conjunction with gas engines. This combination is said to have a considerable future before it, in the larger sizes of vessels; while the gasoline engine, *per se*, using the liquid form of the fuel rather than the gaseous, takes care of those of smaller dimension. This is as yet, however, entirely in the experimental stage, and cannot be considered as an immediate factor in the question.

All of these changes, if changes they are to be, are of great importance, but, as in the case of the accomplished introduction of the steam turbine, cannot be said to be revolutional in character, as was that of the steam engine, nearly a century ago. The motors proposed are all heat engines; all operate one or more screw propellers, as has been largely the case for the past fifty years; all types and forms are reciprocating in character, the steam turbine alone excepted (for the much-heralded gas turbine has thus far attained no definite status as an agent of propulsion); all depend for their efficient performance upon the coincident operation of a certain number of auxiliary devices and appliances, much the same in character for the varying types; and, lastly, all call for the consumption of large quantities of fuel, which must be carried on the voyage, and which cut down, to the extent of their own weight, the amount of cargo which can be transported.

Putting aside, therefore, all idea of changes of an extremely radical character, it will be seen that the field of future improvements becomes narrowed to the question of obtaining here and there small economies in operation—here a waste (heat or otherwise, but always, in the limit, heat) decreased or cut off entirely; there a device introduced to improve the effectiveness of some part of the total entity which may, perhaps, have been previously overlooked as of too small importance in the whole scheme to merit serious consideration. And from this gradual refining process may be expected most of the improvements of the immediate future.

The Screw Propeller and Marine Machinery.

With this issue we conclude the exhaustive discussion upon the design and operation of the screw propeller, from the pen of Professor Durand, which has run through four numbers. The importance of possessing accurate information upon such a subject is very great indeed, and is rapidly becoming more so with the introduction of higher rates of speed and of revolution. One of the main avenues for refinement in economy of operation lies right here, and the question is destined to receive a large measure of attention in the near future.

We hope to resume, in June, the series of articles by Professor Durand upon the Design of Marine Machinery, which was interrupted more than a year ago by pressure of work falling upon the author.

ABSTRACTS FROM RULES AND REGULATIONS OF THE AMERICAN BUREAU OF SHIPPING.

EDITION OF 1904.

ARRANGED BY HARRISON S. TAFT.

PART II.

17. Deck Plating, Deck Stringers and Tie Plates.

1. The deck stringers and deck plating should maintain their midship scantling for half length amidships.

2. Steamers not requiring a complete or partial steel deck must have a steel deck of at least 10 pounds worked over the boiler and engine space. Said deck is to extend one beam space fore and aft of said space and thence taper into the deck stringer.

3. Coal bunkers located between the boiler and engine rooms are to have a complete steel deck worked over the same.

4. Partial steel decks should taper for at least 6 frame spaces beyond their required length of 1-2 length amidships into the stringer and tie plates.

5. Steel decks should be worked continuously through all bulkheads.

6. The plating at the mast partners, large deck openings, and at all heavy fittings should equal the weight of the deck stringers amidships.

TABLE 7.—TIE PLATES AT LARGE DECK OPENINGS.

Length of Opening.	Width of Tie Plates.	Notes.
12 feet under 16 feet	1½ times regular width	Tie plates of extra width are to taper for 3 frame spaces into regular width.
16 " " 20 "	Twice regular width	
20 " and above	a. Twice regular width and the deck plated over in wake of said opening with 10 lbs. plate.	a. Said plating is to extend one beam space beyond each end of said opening.

7. When no steel deck is laid tie plates are to be fitted on each side of the middle line on each deck, so as to take the coamings of hatches, etc. Diagonal tie plates are to be worked on the upper decks of all sailing vessels not having a steel deck, radiating from mast partners to stringers, to which they are to be double riveted. Discontinuous tie plates are to lap each other at least one beam space.

8. Mast Partners. They should extend fore and aft 2 beam spaces for alternate spaced beams, and 4 beam spaces for every frame-spaced beam. They should be three times the diameter of the mast hole in width and of the same weight as the deck stringer amidships. The coaming rings are to be of the same scantling as the midship frames.

18. Hold Stanchions.

1. Said stanchions should be fitted at the center line to every beam for 3-5 length amidship, and on alternate beams fore and aft of same. They should have at least two rivets in each end. The hold and the deck stanchions should be placed over each other.

2. When beams are fitted to every frame the stanchions are to be fitted at alternate beams to a strong back fitted under said beams and clipped to same.

TABLE 8.—SPACING OF QUARTER STANCHIONS ON EACH SIDE OF CENTER-LINE STANCHIONS.

Vessel's beam	44 feet under 56 feet	56 feet and over	Sailing vessels over 40 feet.
Spacing of stanchions	On alternate beams	On every beam	On alternate beams for ⅗ L.

When vessel's beam is under 44 feet only the center row of stanchions need be fitted.

3. Stanchions are to be fitted to all beams under the windlass, capstan, deck engine, etc., and under the fore-and-afters of hatchways over 6 frame spaces in length.

4. Masts stepped on a deck are to have extra stanchions fitted to the three deck beams under said step.

5. Hold stanchions over 14 feet in length, and deck stanchions over 8 feet in length, are to be made respectively 1-2 and 1-4 of an inch larger in diameter than otherwise.

6. Bulwark Stanchions. They should be spaced not more than 6 feet apart and are to be from 1 1-4 inches to 2 inches in diameter. They should have spurs to the bulwarks, with doubling plate at same.

19. Bulkheads.

1. There shall be a transverse water-tight bulkhead at a suitable distance forward of the stern (except in paddlewheel steamers), with a water-tight flat extending aft to the stern so as to form the aft peak.

2. There shall be a transverse water-tight bulkhead at each end of the machinery space.

3. All of the above bulkheads should extend to the upper deck in all vessels; but to the second deck in hurricane-deck vessels. In three-deck vessels the aft peak bulkhead is to extend to the second deck only.

4. When the cargo space forward or aft of the machinery space exceeds 75 feet in length said spaces shall be divided by an intermediate water-tight bulkhead at the middle of each space. If said cargo spaces exceed 140 feet two intermediate bulkheads shall be worked in each space. Said bulkheads are to extend to the deck next above the deck load water-line.

5. All water-tight bulkheads shall have double frame angles with double top angles connection to the deck plating, and to the inner bottom plating when worked.

6. Stiffeners equal to the midship frames are to be worked vertically on one side not more than 24 inches apart; horizontally on the other not more than 48 inches apart. The horizontal stiffeners shall be bracketed to the shell.

The vertical stiffeners shall be well secured to the floor plates, but bracketed to the inner bottom plating when used. The brackets are to equal the thickness of the flange of the angle bar to which they are riveted.

7. All horizontal stiffeners on the collision bulkheads, and on the lower parts of all other bulkheads, 40 feet or more in width, shall be of bulb angle of specified weight. Vessels of other than American registry can have the vertical stiffeners on the water-tight bulkheads spaced 30 inches apart.

8. *a*. Vessels with hold beams, deep frames, or web frames in lieu of hold beams, of less than 40 feet in breadth, should have the alternate stiffeners on all bulkheads either of deep frames with reverse bar, of bulb angle, of channels, or of Z bars, of specified scantling.

b. When the breadth is 40 feet and under 48 feet, or depth from top of floors to top of the lowest tier of regular deck beams amidships is over 20 feet, all bulkheads should have all their horizontal and vertical stiffeners of the foregoing scantling.

c. When the breadth is 48 feet or over, in addition to the above, all bulkheads are to have, midway top of floors and the lowest tier of deck beams, a girder beam of plate, one frame space wide, with an auxiliary beam supporting its outer edge.

Said plate girders are to be clipped to the bulkhead plating between the vertical stiffeners, and have a continuous face bar clipped to the face of said stiffeners. Said plate girders are to be treble riveted to the side stringers, and have bracket plates, equal to the thickness of the girder plate, single clipped to said girder at alternate stiffeners.

9. Sailing vessels need have but the two end collision bulkheads.

TABLE 9.—LOCATION OF FORWARD COLLISION WATER-TIGHT BULKHEAD.

Length of ship in feet	Under 200	200 under 350	350 under 500	500 and above.
Distance aft of stem in portion of vessel's length	$\frac{1}{10}$ L	$\frac{1}{12}$ L	$\frac{1}{15}$ L	$\frac{1}{16}$ L

10. Center line bulkheads shall have stiffeners equal to the midship frames spaced at every frame. Alternate stiffeners shall be secured to the deck beams and be bracketed at the bottom. The plating is to have double top and bottom angle bar connection of the same scantling as the reverse bars, but they need not exceed 3 1-2 by 3 1-2 inches.

11. Coal Bunker Bulkheads. The plating is to be 2 pounds less in weight than used for the shaft tunnels. The fore-and-aft bulkheads are to have stiffeners spaced 30 inches apart, of the same flange size, but 2 pounds lighter than reverse bars. Every third stiffener is to be stayed to the side framing. The plating is to have a single angle bar of stiffener size at the top and bottom. Athwart ship bulkheads are to have stiffeners of the same scantling as the reverse bars, spaced 30 inches apart, having single top and bottom bars of the same size as the stiffeners, but not over 4 inches by 3 inches, when said bulkhead is not located on a frame.

12. Bulkheads at the front of a full poop and enclosed bridge houses are to be of 10-pound plate when the second number is under 16,500, but of 12-pound plate when the second number is or over 16,500. The height of the coaming plate above the planking is to equal the depth of the main deck beams, and it is to be 2 pounds heavier than the above plating. When the breadth of a vessel is 30 feet the stiffeners are to equal the frames and be spaced 30 inches apart. When said breadth is 30 and under 40 feet, alternate stiffeners are to be doubled. When said breadth is 40 feet of over all stiffeners are to be doubled. All stiffeners are to be bracketed to the deck plating. Said bulkheads should be located over a main deck beam.

13. Doors will not be allowed through a water-tight bulkhead in the lower holds, or through the front of an enclosed bridge house that abuts to a raised quarter deck; nor companion ways in the bulkheads in the front of a raised quarter deck.

20. Boiler Saddles.

Boiler saddles, at the point of their contact with the hull, should equal the diameter of the boiler.

21. Shaft Tunnels.

Second Number.	Weight of Plating.	Notes.
Under 10,000....	Not less than 10 lbs...	Top of tunnel under hatches is to be worked double or be covered with 2 inches of wood.
10,000 " 16,500....	" " " 12 "	Stiffeners equal to reverse bars are to be spaced not over 4 feet apart.
16,500 and above.......	" " " 14 "	To have a W T door at engine room end, which shall work from upper deck.

22. Breast Hooks.

They must be fitted between decks of 7 feet or more in height. In the lower holds or peaks they must not be more than 4 feet apart. They should be clipped to the shell, and have a beam at every frame. They are to be 2 pounds thicker than the side stringers at their ends.

23. Shell Plating.

1. The plates should not exceed 66 inches in width. They should maintain their midship weight for 1-2 length amidships. The plates should not be less than 6 frame spaces in length, except at the hoods, where if shorter than 5 frame spaces they are to be connected to the plates before and abaft same with treble riveted butts.

2. The butts in adjoining strakes are to have at least a two-frame space shift; those in alternate strakes at least a one-frame space shift. The garboard butts must be kept clear of the keel scarphs and have a clear shift of

two frame spaces from each other on the opposite sides. All sheer strake butts are to be shifted at least two frame spaces from the butts of their adjoining deck stringers.

3. When a double bottom is fitted the shell plating within range of said bottom, including the flat keel plates and garboards, may be 2 pounds less in weight than otherwise called for.

4. When the boilers and engines are placed aft the upper deck stringer, sheer strake and top sides shall maintain their midship weight throughout the machinery space, with treble riveted butts.

5. The boss plates and garboard strake plates secured to the propeller post in single-screw vessels are to be of the same weight as their respective strakes amidships.

When the second number is 19,000 or above, all plates connected to the propeller post are to be of the same weight as their respective strakes amidships.

6. Sailing vessels whose second number is 16,500 and under 25,000 should have two bilge strakes, all fore and aft, 2 pounds heavier than otherwise. When said number is 25,000 or above, three bilge strakes, all fore and aft, should be 3 pounds heavier than otherwise.

TABLE 10.—BULWARK PLATING.

Second Number.	Under 8,000	8,000 not over 16,500	Over 16,500
Weight of.......... Bulwark plating....	Not less than 6 lbs.......... 8 lbs. if over 3 feet high....	8 lbs.	10 lbs. 8 lbs. if less than 3 feet high.

Length of bulwark plates should be a multiple of stanchion spacing so that said stanchions may come at a butt of said bulwark plates.

7. If the holes in the sheer strake for side port lights which are located within the range of half the vessel's length amidships are or exceed 9 inches in diameter, the sheer strake is to be reinforced at said lights.

8. When single butt straps of a main sheer strake are worked on the inside and are cut at the upper deck stringer, the top of the sheer strake must extend above the gunwale bar so as to allow of two horizontal rows of rivets for said strap worked above the deck stringer gunwale bar, said strap being joggled and fitted into the throat of the gunwale bar and riveted thereto.

9. The main sheer strake must not be cut for a freight or coal port.

TABLE 11.—MINIMUM WIDTH IN INCHES OF KEEL, GARBOARD, AND SHEER STRAKES.

Second Number.	Under 10,000	10,000 under 16,500	16,500 under 25,000	25,000 under 48,000	48,000 under 80,000	80,000 and above.
Flat keel plate....................	27	30	33	36	56	36
Garboard strake..................	30	33	36	39	42	45
Sheer strake.......................	33	36	40	44	48	54

For ⅗ length amidships.

24. Freight Ports.

When cut in the sides of the ship between decks (below upper deck sheer strakes), if of more than two frame spaces in width, said ports must have web frames at each end, extending from deck to deck, and connected to same with double clips. The shell strakes above and below said openings must be doubled for three frame spaces fore and aft of said doors.

25. Butt Straps.

1. Single butt straps must be at least 2 pounds heavier than the plates they secure; but when triple riveted 4 pounds heavier than the plates they secure. The thicker of the two plates is to determine the weight of said strap.

2. Double butt straps must not be less than 3-4 the thickness of the plates they secure.

3. Butt straps of the flat keel plates are to be at least 6 pounds heavier than plates they secure.

4. Butt straps of floors, web frames, all continuous keels and keelsons must be worked double.

5. Bosom pieces to angle bar butts must be of the same thickness as the bars they secure.

6. Butts of the angle bars of the floor or bilge double angle bar keelsons are to have a 12-frame space shift of each other.

7. Butts of the plate side stringers or their angles must not come at a web frame.

8. Butt straps of all shell plates 54 inches or more in width are to be at least 5 pounds heavier than the plates they secure.

9. Butt straps of an upper deck stringer (second deck in hurricane-deck vessels) 54 inches or more in width should be worked double; but when the stringer is worked double, said butt straps can be worked single.

10. Shell Plating and Deck Stringers. See Table 12.

11. Single butt straps of the upper deck sheer strake, second deck in hurricane-deck vessels, when equal in width to and fitted on the inside of said strake, are to have the gunwale bar joggled around them, or else liners fitted between said bar and the sheer strake plate. When said butt straps are cut at the deck stringer, the part of said straps above the deck stringer are to have two horizontal rows of rivets through the sheer strake above the gunwale bar, and they shall joggle over into throat of said bar and be riveted thereto.

12. Shell doubling plates are to have butt straps 4 pounds heavier than said doubling plate.

13. Butt straps of all masts and spars are to be 3 pounds heavier than the plates they secure.

14. Bulb plates at their butts should have the bulb cut off on each side so as to allow a full width butt strap.

15. Single butt straps of deck ties, stringers, and deck plating should be fitted on under side.

26. Riveting.

1. With plates of different thickness the thicker of the two is to regulate the diameter of the rivets.

2. Tap rivets should be 1-8 of an inch larger in diameter than the corresponding ordinary rivet.

3. Bar keels, stems, and stern posts should be double zigzag riveted. The rivets should be 1-4 of an inch larger in diameter than those used in riveting the garboards to their adjoining strakes.

4. With a vertical center line keel and keelson the garboards must be double riveted to same, with an intermediate row securing the side plates to the center line keelson plate before the garboard plates are put on.

5. Flat plate keels; floor plates; web frames; horizontal floor stringer plates; all continuous keels, keelsons, and rider plates must have treble riveted butts throughout.

6. The laps or edges of water-tight bulkheads and the longitudinal laps or seams of steel decks should be single riveted. Vessels whose second number is or above 14,000 are to have their bulkhead plating double riveted to the floors.

7. The longitudinal laps of all shell plating under 16 pounds worked in and out (those of lower edge of sheer strake under 14 pounds) are to be single riveted; but when of 16 and 14 pounds respectively and above, said seams are to be double riveted. The type of midship riveting is to be carried all fore and aft.

8. The flush longitudinal seams of all shell plating under 20 pounds are to have single riveted edge strips; but for 20-pound plating and above, double riveted edge strips.

9. All double riveting of longitudinal laps and seams is to be chain fashion.

10. All butts of shell plating, deck stringers, and deck plating should be at least double riveted.

11. The lapped butts of shell plating for vessels whose second number is under 16,500, are to be treble riveted for 1-2 length amidships and double riveted at ends. If said number is or over 16,500, said butts are to be treble riveted throughout.

12. Butt straps of all shell plates 54 inches or more in width are to be treble riveted.

13. Shell Plating and Deck Stringers.

TABLE 12.—BUTT STRAPS AND RIVETING SCHEDULE FOR SHELL PLATING AND DECK STRINGERS.

	Second Number.	10,000 under 16,500	16,500 under 22,000	22,000 under 30,000	30,000 under 48,000	48,000 and above
Butt straps of:	Sheer strake	T R+4 Lbs.—$\frac{1}{2}$ L	T R+5 Lbs.—$\frac{1}{2}$ L	T R+6 Lbs.—$\frac{3}{4}$ L	T R+7 Lbs.—$\frac{3}{4}$ L	T R T+10 Lbs.—$\frac{3}{4}$ L
	First bilge strake	T R+4 Lbs.—$\frac{1}{2}$ L	T R+5 Lbs.—$\frac{1}{2}$ L	T R+6 Lbs.—$\frac{3}{4}$ L	T R+7 Lbs.—$\frac{3}{4}$ L	T R T+10 Lbs.—$\frac{3}{4}$ L
	Second " "	D R+2 Lbs.	T R+5 Lbs.—$\frac{1}{2}$ L	T R+6 Lbs.—$\frac{1}{2}$ L	T R+7 Lbs.—$\frac{3}{4}$ L	T R T+10 Lbs.—$\frac{3}{4}$ L
	Remaining "	D R+2 Lbs. T H T	D R+2 Lbs. T H T	T R+6 Lbs.—$\frac{1}{2}$ L	T R+7 Lbs.—$\frac{3}{5}$ L	T R T+10 Lbs.—$\frac{1}{2}$ L 5 Lbs. at ends
	a. Upper deck stringer	D R+2 Lbs. T H T	D R+2 Lbs. T H T	D R+2 Lbs. T H T	T R+7 Lbs.—$\frac{3}{4}$ L	T R T+7 Lbs. T H T
	Lower " "	D R+2 Lbs. T H T	D R+2 Lbs. T H T	D R+2 Lbs. T H T	D R+2 Lbs. T H T	T R+7 Lbs.—$\frac{1}{2}$ L
	Shell plates over 54″ wide	T R+5 Lbs.	T R+5 Lbs.	T R+5 Lbs.	T R+10 Lbs.	1 Lb. heavier than otherwise
	Deck stringers over 54″ wide	D R+double straps	D R+double straps	D R+double straps	T R+10 Lbs.	T R+double straps

a. Second deck in hurricane-deck vessels.
D R = double riveted; T R = triple riveted; T H T = throughout; T R T = triple riveted throughout.
Plus sign (+) means "with." Minus (—) means "for."
Example; T R + 4 lbs. — $\frac{1}{2}$ L means: triple riveted butts with straps 4 lbs. heavier than the plates they secure for $\frac{1}{2}$ length amidship.
All the above triple riveted butts to have three complete rows of rivets.
Flat keel plates are to be triple riveted throughout and have straps 6 lbs. heavier than the keel plates.

14. In three-deck vessels, the butt straps of the sheer strakes, of the upper-deck stringer, and of at least two bilge strakes should be triple riveted for 3-5 length amidships.

15. When the engines and boilers are placed aft, the butts of the upper deck stringer, of the sheer strake and top sides should be at least treble riveted throughout the machinery space.

16. The two shell butts fore and aft of a shell doubling plate should be treble riveted. The doubling plates are to have treble riveted butt straps.

17. The longitudinal seams or edges of the inner bottom plating should be single riveted, except the laps or edges of the middle line strake, which are to be double riveted to the adjoining strakes. All athwartship butts are to be double riveted throughout.

18. Hatches on the upper decks and on the second deck of hurricane-deck vessels, and deck houses fitted over a deck opening, should have their coaming plate butts treble riveted.

19. Deck tie plates, laps, and butts should be double riveted.

20. (*a*) The seams or laps of all lower masts should be double riveted. If the length of the mast from the partners to the hounds exceeds 45 feet all butts above the partners are to be treble riveted. If said length does not exceed 45 feet only the butts of the lower half above the partners need be treble riveted, those in said upper half being double riveted.

(*b*) When the lower mast and top mast is made in one length the seams or laps may be single riveted; with double riveted butts throughout.

(*c*) The seams or laps of the topmasts and of the yards should be single riveted; with treble riveted butts throughout.

(*d*) The seams or laps of the bowsprits must be double riveted; butts outside of the gammoning are to be treble riveted, with those inside double riveted.

21. Angle bosom pieces should have at least 3 rivets on each side of their butts.

22. Keelson floor clips should have at least a 3-rivet connection to all floor plates.

23. Keelson rivets passing through four thicknesses of plate are to be 1-8 of an inch larger than otherwise.

24. Plug-neck rivets should be used in the shell plates, deck stringers, tie plates, and inner bottom plating.

25. The maximum weight of the shell plating outside of the sheer and garboard strakes is to determine the

size of the shell frame rivets. The frame rivets for the garboards and the sheer strakes are to be of the same diameter as for other strakes. The size of the frame rivets in the side plating above the second deck sheer strake in hurricane-deck vessels is to regulated by the thickness of the frame's web.

26. Surfaces of all plates and angles should be well painted before being riveted together.

TABLE 13.—COUNTER SINK ANGLES FOR RIVETS.

Diameter of rivet in inches........	¼ to ⅝ inc.	¾ to ⅞ inc.	1 to 1¼ inc.	Above 1¼
Angle of countersink	53°	45°	37°	32°

The countersink is to extend to within $\frac{1}{32}$ of the depth of the plate or the flange of the angle bar.

Countersinks for tap rivets are to have a maximum diameter of from 1.4 to 1.5 times the diameter of the rivet shank: Depth of same is to be from .4 to .5 times diameter of said shank.

27. Double Bottoms.

1. When the frames are cut at the margin plates, frame brackets are to be fitted on both sides of the margin plate at every frame, when the floor plates do not extend to the inner bottom plating. But when the floor plates do extend to the inner bottom plating, aforesaid frame brackets are to be fitted at outside of the margin plate to those frames only on which the floor plates are worked

TABLE 14.—FRAME AND FLOOR BRACKET CLIPS. SPACING OF GUSSET PLATES.

Second Number.	Under 30,000	30,000 and Above.	26,000 Under 42,000.	42,000 and Above.
Said clips to margin plate....	a. Single.	Double.	......	......
Spacing of gusset plates......	......	......	Every third frame.	Alternate frames.

a. Single clips are to be worked opposite to each other.

Gusset plates are to equal thickness of the inner bottom plating, and be worked throughout the inner bottom space.

A continuous plate stringer may be worked in lieu of the gusset plates.

2. The plating should be worked fore and aft. When worked flush the edge strips should be fitted on the upper side; butt straps on the under side. When a wooden ceiling is laid on an inner bottom the butt straps can be located on the upper side.

3. Longitudinal Girders on Top of Floors.

Said girders should be spaced not more than 40 inches apart. They are to be at least 15 inches high, with single top and bottom angle bars. Swash plates of 10 to 12 pounds are to be worked in way of the longitudinal midway between the center line and bilge. When the middle line girder on top of floors is worked in connection with an intercostal or continuous center line plate keelson, it may be made lighter than otherwise.

4. Cellular Bottoms with Continuous Longitudinals.

(*a*) Such bottoms should have a continuous center line plate keelson with continuous side longitudinals spaced not more than 5 feet apart. When the second number is under 10,000, floor brackets are to be fitted on both sides of the longitudinal girders at the top and bottom on alternate frames fore and aft of the machinery space. When said number is 10,000 and under 50,000, solid manhole floor plates are to be fitted at every fourth frame with the above floor bracket plates at the frames midway between said solid floors. When said number is 50,000 or above, the solid manhole floor plates are to be fitted on alternate frames.

(*b*) Under the engine bed solid manhole floor plates are to be fitted on every frame, but on alternate frames under the boilers and other machinery space.

(*c*) The top longitudinal bars are to be single and worked continuously. The bottom bars are to be single, intercostal between the frames. The solid floors and regular brackets are to be double clipped to the center vertical keelson; the intermediate brackets are to have single clips to same. Double bars are to be used throughout in way of the engine and boiler foundations.

5. Cellular Bottoms with Continuous Floors.

(*a*) Fore and aft of the machinery space the floors, double clipped to the center vertical keelson, can be worked on alternate frames if longitudinal bracket plates are worked at top and bottom on each side of said floors. If the second number is not over 18,000, and solid manhole intercostal longitudinal plates are used, the solid floors can be placed on every third frame. If said number is over 18,000, solid floors, fitted with solid manhole intercostal longitudinal plates, should be worked on alternate frames. The longitudinal brackets or the solid manhole floor plates are to have a single clip connection to the floors, shell, and inner bottom plating. Said brackets and floor plates should be spaced not more than 5 feet apart athwartships.

(*b*) Under the engine bed and boilers, the same construction as stated under (27-4-*b*) is to be used.

(*c*) Manholes should be cut in all solid non-water-tight floors between each side longitudinal.

6. When double bottoms are built with solid manhole floors on every frame, said floors shall extend in one piece from the center line to the margin plate, and from the shell to the inner bottom plating, with an intercostal longitudinal plate girder about midway from the center line to the margin plate. Said intercostal girder is to be clipped to floors and shell with angle bars equal to the reverse frames, and have a continuous angle bar on top. Said floors are to be double clipped to the center vertical keelson.

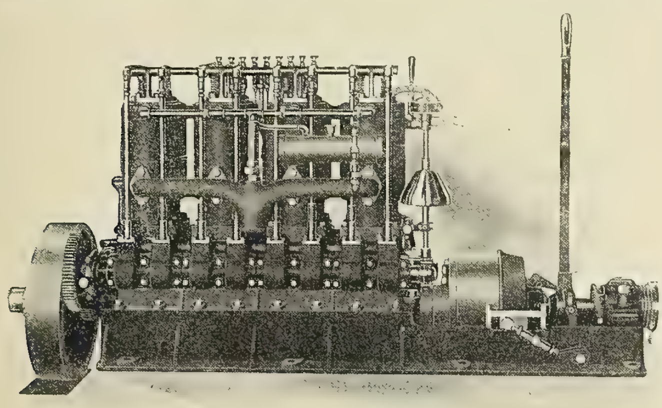
(*To be continued.*)

ENGINEERING SPECIALTIES.

New Lacy Gasoline Engine.

We illustrate herewith a new type of the Lacy gasoline engine, manufactured by The Brown-Cochran Company, Lorain, Ohio. Many features of decided merit are incorporated in this engine, among which may be mentioned accessibility, perfect control, quiet running, and freedom from adjustments. Quality and efficiency have been considerations of first importance. Valves are placed directly in the head of the cylinder and are set in cages which may be readily removed by simply loosening two nuts. Special attention has been given the mechanism for operating the valves. Cams are large and so designed as to do their work with but little noise.

The carburetor is of the float-feed type and furnishes a uniform mixture at all speeds. An efficient governor controls the throttle valve and a hand lever is provided for controlling when desirable independent of the governor. Ignition is by jump-spark, or make-and-break, at the option of the purchaser. In

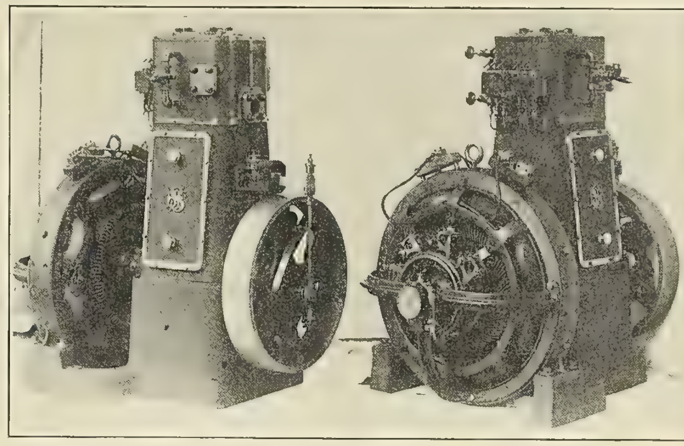


either case the most approved devices are employed. Great care has been taken to produce a serviceable and efficient reversing gear. Ample proportions have been used and materials selected which would stand hard usage. The clutch is of the multiple plate type. Friction surfaces are large, avoiding frequent adjustment. It is impossible for the clutch to seize. The thrust bearing is so designed that no end motion can be worn into the parts of the reversing gear or crank shaft.

A point worthy of consideration is that all controlling levers are arranged to be conveniently reached by the operator standing at the reversing lever. The matter of oiling has been carefully considered and a very satisfactory system developed. A multiple feed oiler furnishes lubrication to all bearings subjected to hard wear and to the cylinders. This oiler is provided with eight feed glasses of large size. Bearings throughout are liberal, thus insuring long life, even with most severe service.

A New Sturtevant Generating Set.

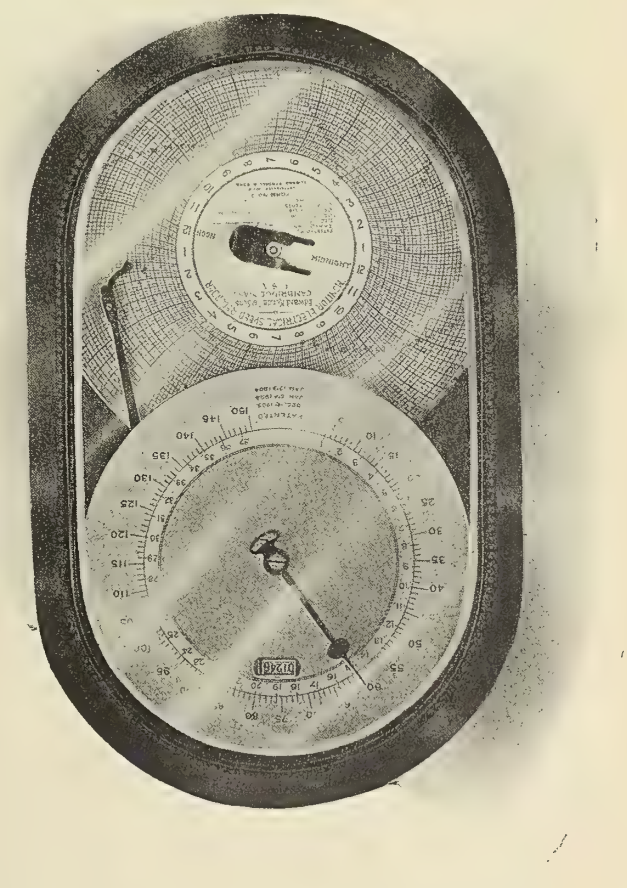
Originally built by the B. F. Sturtevant Company, of Boston, Mass., for the use of the United States government, and in accordance with specifications of the Bureau of Equipment, this generating set possesses features of special interest. The engine is of the high-speed reciprocating type, designed to run at 650 revolutions per minute. The cylinder, which is cast with the frame, is 4 1-2 inches diameter and 4 1-2 inches stroke. The valve is of the balanced piston type, and is operated by a Shepherd governor attached to the fly-wheel. Quick action and regulation within 1 1-2 percent from full load to no load is secured with this governor. The engine is remarkably silent in its working and is of a type especially desirable for modern yachts and similar service.



The generator is of the eight-pole type, designed for a continuous output of 5 Kw. at 650 r. p. m. It is capable of carrying for short periods of time, 50 percent overload, without shifting of brushes or flashing at commutator, and is capable of continuous operation at 25 percent overload without sparking or undue heating. After a continuous run of ten hours, at full load, the increase in temperature above that of the surrounding atmosphere will not exceed 40 degrees C. in any of its parts. The insulation resistance is such that it will withstand a break-down test of 1,500 volts for a period of one minute and shall show a resistance of at least one megohm with an initial voltage of 500. The total weight of the set, which includes the engine, generator, and sub-base, ready for operation, is 1,140 pounds.

The Monitor Electrical Speed Recorder.

This little instrument is the outcome of the experiments of two retired engineers of the United States Navy. A simple, yet very ingeniously contrived circuit closer and breaker, is placed



on the end of the shaft, or in the shaft alley, and from this are led the wires to the instrument, which may be placed in any part of the ship. Instantly upon the engines turning over, the hand upon the dial starts marking each revolution until one minute is up, when the hand will stop, registering the exact number of revolutions per minute. It will stay at this point, unless there is a difference in the succeeding minute, in which case the hand will fall back, or advance, and accurately show the varying speeds. On the face of the instrument is an ordinary counter reading up to 10,000 revolutions, so that readings can be taken at any time. In the instrument is a time chart or disc, which revolves once in 24 hours, the face of which is divided into circles and arcs corresponding with the dial face; a swing pen is attached by positive movement, to work in conjunction with the hand upon the dial, and this dial being divided into six four-hour watches, can be taken off, dated, and filed away for future reference, thereby keeping a perfect log.

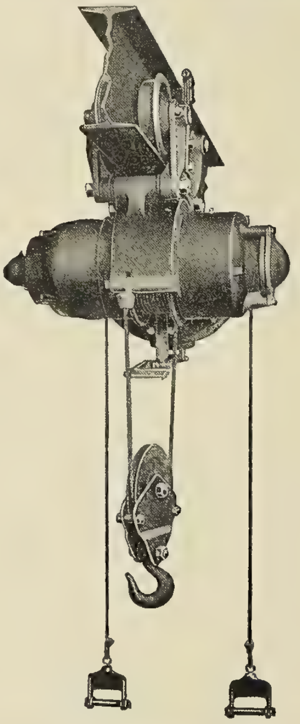
In connection with this is an automatic circuit closer and breaker, which may be placed on the taffrail, and by towing the log, or rotator, the indicator in the pilot house will at a glance show just how fast the vessel is traveling through the water, the range in nautical miles being from 0 to 38 knots; and also keep an accurate record of the same on the time chart, before mentioned. This combination, a dial of which is graduated into knots and revolutions, makes a very convenient instrument for merchant steamers, and is finding a ready sale where it has been introduced; for the master can see at a glance just how fast the vessel is traveling through the water, and by turning a switch can see also just how many revolutions the engines are making. Another unique device in connection with this is the engine annunciator, showing the direction that the engines are running. This is placed near the bell pull in the pilot house or on the rail.

Again, upon using the standard anemometer cups adopted by the weather bureau, and a specially contained circuit breaker and wiring to the same machine with a different dial, the wind velocity can be read at a glance, from 0 to 150 miles per hour or over, and an accurate record left upon the time chart, as in the other cases. It is also finding great favor with leading yacht clubs, being placed on the roof of the club house, where the cup revolutions open and close the circuit breaker, and the instrument itself, placed in the parlor of the club house, may be referred to at any time.

The instrument is an ornament to the chart room of a private yacht or house boat, is inexpensive, and can be installed at short notice by an ordinary mechanic or ship's electrician. The after care is very small, simply winding the clock once in eight days, filling the pen once a week, and putting on the chart or paper disc once in 24 hours. Masters or owners of vessels or private yachts, by corresponding with the Monitor Electrical Speed Recorder Company, P. O. Box 71, Cambridge, Mass., will be supplied with full details and particulars.

A New Electric Hoist.

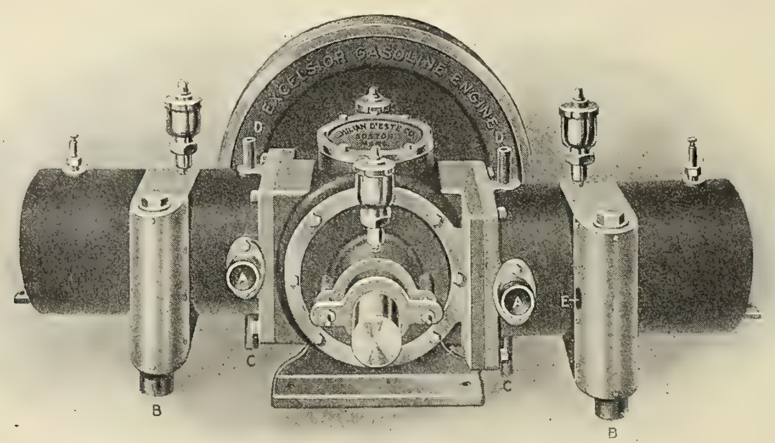
The Shepard electric hoist is constructed on lines entirely different from those of any others. It solves the problem of reducing the hoisting apparatus of the modern electric traveling crane to a self-contained and easily accessible machine, small and simple enough to be able to compete successfully in such intermittent or minor operations as serving machine tools, lifting



copes, setting cores, etc. It combines simplicity with high efficiency, strength and durability with comparative lightness. It has a speed control which will satisfy the most exacting, and the head-room required is so small that it is perfectly adapted for location under galleries, beneath belts, or in low rooms where any less compact hoist could not be used at all. The price is low enough to permit its employment with profit in any class of hoisting to which power may be applied to advantage. It is manufactured by the General Pneumatic Tool Company, Montour Falls, N. Y.

The Excelsior Gasoline Engine.

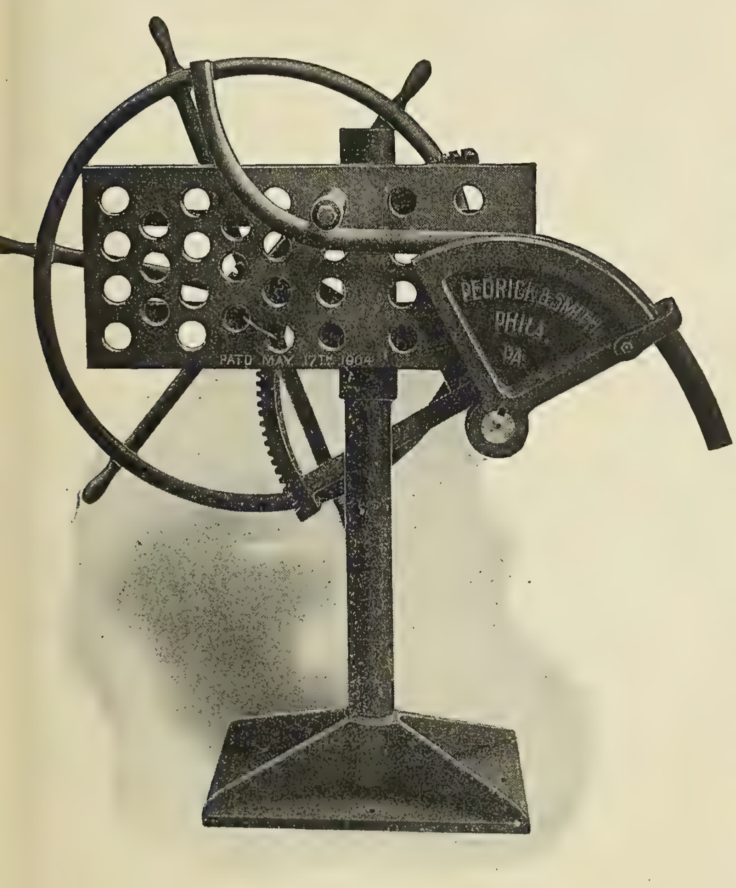
This engine is built in two distinct types: the horizontal opposed and the vertical, and is a two-cycle engine for marine work, embodying all the good features of the best marine engines, such as spark-plug ignition, no valves coming in contact with the fire to give trouble, receiving charge through induction port, car-



buretor instead of vaporizer; in addition these engines have several features of their own, such as automatic reversing device, adjustable bearings made of bronze, great speed range, arrangements to prevent back firing in crank-case, high compression (giving great efficiency), semi-automatic grease lubrication throughout, and the use of ground joints instead of packing. The greatest care and attention has been given to the correct proportioning of all parts for strength and selection of material for the greatest wear. This has enabled the builders to produce a perfectly reliable engine, durable, economical, light, compact, and powerful.

To reverse this engine all that is necessary is to throw over the lever, as in a steam engine, and the engine will reverse itself automatically. This is a very important feature, when one person is alone in handling a boat, as it gives time for attention to other things. Since the auxiliary engine is becoming almost a necessity in a sailboat which is used for business or pleasure purposes, the remarkably small amount of fuel used, and the lightness of the engines, with their adaptability for this particular work, together with the automatic reversing device, would recommend the Excelsior gasoline engine to anyone.

These engines are furnished complete with all accessories, or the engine alone, as preferred. The builders, however, recommend that the purchaser buy the engine complete, with propeller, shaft, stern bearing stuffing-box, and muffler, as the parts are made specially for the engine and the best possible results can be obtained from them. For prices and further particulars address the Julian D'Este Company, 24 Canal street, Boston, Mass.



A New Pipe-Bending Machine.

This machine, while being of a somewhat simple character, will accomplish a great variety of work in line of its intended duty. It requires the services of an ordinary helper only, who can, with the aid of this machine, bend pipe to any desired complex curvature in a very short time. The machine is operated by a handwheel which carries a pinion. The latter engaging a quadrant-gear operates the bending quadrant. One end of the pipe which is to be bent is held in position by a U-shaped clip while a pin or roller in the platen engages the other end. The placing of the pin or roller in the different holes governs the curvature obtained.

Being light in weight it is readily carried from shop to job, or *vice-versa,* and can be secured to any column, stanchion or any available support in a few minutes, or a suitable stand can be furnished, as shown. Piping of steel, iron, brass, copper, or other materials up to 2 inches diameter, can be bent cold. It has a great value in shipyards, pipe-shops, locomotive-works, sugar-houses, and other places where pipe is used to any extent. Makers of heating plants, structural and architectural iron workers, fire-escape manufacturers, will find this portable pipe bender especially useful. It is also well-adapted for the use of special dies that can be readily attached for bending light angles, flats or tee bars to any desired radius as easily as bending pipe. One man can, without assistance, bend a piece of 2-inch pipe to an S-bend in three minutes. The cost of repairs, where it has been used ten hours per day in shipyards, railroad shops, and other places, has been so slight in nature as to be a negligible quantity. The machine is constructed by Pedrick & Smith, of Philadelphia.

TECHNICAL PUBLICATIONS.

The Naval Constructor. By George Simpson, M.I.N.A. 588 pages, 4 by 6 inches; 288 illustrations. 1904, Kegan Paul, Trench Trübner & Company, Limited, London; and D. Van Nostrand Company, New York. Bound in leather. Price $5.00 net.

This handbook has been prepared with the object of supplying a ready reference for those engaged in the design, construction, and maintenance of ships. It contains a large amount of new and original matter, prominent in which are a chapter on design and tables of standardized fittings and details. It is divided into seven sections, of which the first treats of ship calculations, being devoted to the displacement, buoyancy, stability, launching, strength, speed, and power of ships, and the preparation of specifications. The second section deals with the strength of materials used in the construction of ships, including timber, and the various qualities of structural sections. The third part is devoted to fittings and details; the fourth to the rigging and ropes of the vessel; the fifth gives dimensions of the various minor equipments, such as boats, anchors, etc., besides giving requirements of the Board of Trade, Supervising Inspectors, and yacht-racing rules. The last two sections are devoted to tables of materials and to various mathematical tables. The work as a whole should find a ready adaptation to the needs of the up-to-date ship constructor and designer.

Dimensions of Pipe Fittings and Valves. By W. D. Browning. 82 pages. 1904, The Draftsman, Cleveland O. Price, bound in flexible cloth covers, 50 cents; in leatherette, 75 cents, postpaid.

This book contains a large assortment of useful diagrams and tables, with descriptions of the styles and uses of valves and pipe fittings. It has also useful information on the subject of steam heating and pumps. There are over fifty tables of dimensions, most of them taken from actual measurements, others compiled from trade catalogues.

Maxwell's Theory and Wireless Telegraphy. Part I.—Maxwell's Theory and Hertzian Oscillations. By H. Poincaré. Translated by Frederick K. Vreeland. Part II.—The Principles of Wireless Telegraphy. By Frederick K. Vreeland. Pages 255; illustrations 145. 1904, New York: McGraw Publishing Company. Price $2.00.

The object of this book is to give a physical treatment of Maxwell's theory and its applications to some modern electrical problems; to set forth the fundamental principles which, according to Maxwell and his followers, underlie all electrical phenomena; to show how these principles explain the ordinary facts of electricity and optics; and to derive from them a practical understanding of the essentials of wireless telegraphy. The purpose not being to either establish or defend a theory, mathematics and abstruse reasoning have been avoided. It has been the intention to pick out the fundamentals which have stood the test of time and are now generally accepted, and to put them in such form that the busiest man may use them, or the student may take them as stepping stones to the more advanced theory.

The second part of the book has been taken up at the point where M. Poincaré dropped it, the line of thought being carried into the practical field of wireless telegraphy, and the principles laid down in Part I being applied to the various problems involved. Certain typical systems have been described, and explanations offered to show why some have failed and others succeeded, and to explain their mode of operation in the light of Maxwell's ideas. The book is not intended as a treatise on the subject, and no attempt is made to describe the myriad forms of apparatus. The object is to deal with principles and to trace the essential features of the development of the art.

Suction Gas. By Oswald H. Haenssgen. 88 pages; 4 illustrations. 1904, The Gas Engine Publishing Company, Cincinnati, O.

The development of a system of prime movers operated by suction or producer gas has attained much greater advancement in Europe than in the United States, where large supplies of liquid or gaseous fuel are at hand for the use of internal combustion engines. Recently, however, the subject has acquired a good deal of interest in the United States, and individuals have endeavored to investigate the general subject and to obtain reliable information on the economy to be obtained from the use of producer gas. It is believed that this work is the first reliable book upon this subject, and that it ought to fill a considerable place where information is required regarding the design, operation, cost of running, development, and possibilities of this type of gas producer.

Cyclopedia of Applied Electricity. Published in five volumes containing about 2,200 pages, over 3,000 illustrations. Bound in three-quarters red leather. List price $30.00; special introductory price $18.00. Published by the American School of Correspondence, at the Armour Institute of Technology, Chicago, 1905.

This work is one of the most comprehensive works on electricity and its practical applications that has yet been published, and should prove invaluable to electricians, engineers, telephone and telegraph operators, engineering students, and any person who has occasion to use electricity in any form. To be able to turn quickly to any phase of electricity as used in our great industries is of immense value to both the busy practical man and the engineering student. In these volumes the reader finds a treatment of the latest developments of electricity by acknowledged authorities, fully indexed, and written in a simple, direct way, free from difficult mathematics, and especially adapted to the needs of the busy practical man.

The work is not addressed to the technically educated specialist, and for this reason all of the descriptions and explanations which it contains have been simplified to the utmost possible degree consistent with a thorough presentation of the subjects treated. Higher mathematics have been entirely omitted, and the subject matter of the work is explained in simple language in connection with a large number of diagrams prepared especially for the text. The half-tone engravings are of special value as they illustrate all of the electrical machines and apparatus made by the prominent electrical companies in the United States, and therefore acquaint the reader with the types of apparatus used in current engineering practice.

The subject matter is divided into chapters or sections with a view to using the work as a text book, and the closely related subjects are brought together under a number of general headings. A great deal of attention has been given to practical examples, and each volume is supplemented with a list of review questions by means of which the reader can test for himself the knowledge which he has acquired of the subjects treated.

The usefulness of the cyclopedia as a reference book is augmented by the addition of a subject index contained in the fifth volume. The practical value of the work as a whole can hardly be questioned, as the cyclopedia embodies the various electrical courses which have been successfully used by the American School of Correspondence in teaching thousands of electricians. The work is, in fact, the outcome of a most successful method for the education of the busy man. It will be found of the greatest value to designers, constructors, and operators of electrical machinery, and as it is the only text book and reference work covering every department of electricity thoroughly, its use will save many valuable hours of search among scattered text books on electricity.

QUERIES AND ANSWERS.

All reasonable questions concerning marine engineering received from and signed by subscribers will be answered by the editor in this column. All communications must bear the name and address of the writer.

Q. 275.—I wish you would please give me some information in your next issue on the following subject:

A light draft boat is under construction here; they claim it will draw 10 inches light; the boat is 50 feet long, 15 feet beam and has two 30-inch tunnels aft, 12 feet long, open at bottom, and a 28-inch screw in each tunnel. They claim the screw in turning forces the air out, and the tunnels naturally fill up with water, and they get as much power as if the screw were in deep water. How is this, is it right? H. T. Y.

A.—The claim that screw tunnels on a light-draft steamer will fill up with water when the boat is in rapid motion is quite correct. The stream lines and the action of the propeller combined operate to raise the level of the water in the tunnel to a point considerably higher than that outside, and unless the top of the tunnel is very much above the general surface of the surrounding water the tunnel will completely fill, and the propeller will be working in an unbroken mass of water.

Q. 276.—Please answer in your next issue the following questions:

Show how an indicator diagram will be affected by a faulty setting of either eccentrics or valves, or leakage past the high-pressure slide valve; supposed to be taken from a triple-expansion engine. P. L. S.

A.—(1). When the angular advance of the eccentric is too small all the operations of the valve are too late. The admission lines slope inward at the top, compression corners are too small, and release so late that the steam cannot reach exhaust pressure until the next stroke is nearly completed. This state of affairs is illustrated in Fig. 1.

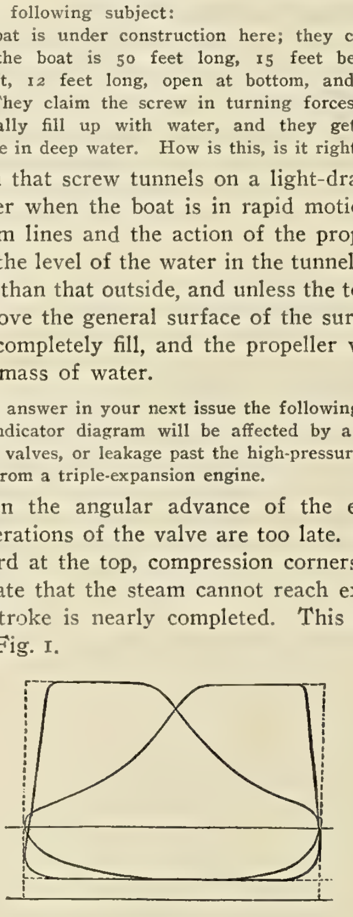


FIG. 1.

(2). When the angular advance of the eccentric is too great the operations of the valve are all too early, with resultant enormously exaggerated compression curves.

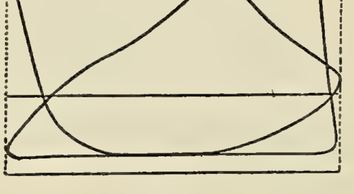


FIG. 2.

(3). When the eccentric is properly set, but the valve is incorrectly placed upon the rod, the lap at one end of the stroke will be excessive and at the other end deficient. The valve will therefore at one end admit steam too soon and continue the admission too long, giving too late a cut-off, and resulting in a diagram similar to that at the left side of Fig. 2. Release is here too late, and the exhaust period shortened. The right-hand diagram shows the effects at the other end to be quite the reverse: steam admission late and too short, cut-off too soon, exhaust commencing early and continuing late.

(4). Leakage past the valve results in the continued admission of steam after the cut-off has occurred, thus reducing the effective expansion and increasing the mean effective pressure. In some cases a part of this steam leaks into the exhaust side and raises the back pressure. Both results are detrimental to economy. When this leakage occurs in the high-pressure cylinder of a multiple-expansion engine, the leakage in itself is not so serious a matter as with a simple engine, as the steam which does no work in the first cylinder may still be used in a later one; but the effect on economy is much the same sort of thing.

Q. 277.—Would you please answer the following: What would be the best arrangement of air, feed, and circulating pump for a steam launch of 26 I. H. P.? Would it be best to have each driven independent, or the three by one steam cylinder? What size air pump would be required for the above horsepower? Also circulating pump? Or perhaps you can tell me of some practical book which has this in it; also the price. L. W.

A.—For small boats, such as the case to which you refer, the favorite arrangement is to include the air and circulating pumps in one combination and to operate the feed pump independently. If you consult the catalogues of leading pump makers, you will find listed various arrangements of combined air and circulating pumps, mounted either with the condenser or separately. You should have a circulating pump capable of handling about 75 gallons of water per minute at a reasonable speed, with a surface condenser of 50 to 60 square feet of surface, and an air pump with a displacement capacity of about 10 cubic feet per minute.

Your feed pump should be capable of handling at moderate speed 6 to 7 gallons of water per minute.

The approximate size of such pump would be about as follows:

Combined air and circulating pump; steam cylinder 5 1-2 inches, air cylinder 6 inches, circulating pump cylinder 6 inches, stroke 7 inches.

Feed pump: steam cylinder 3 1-2 inches, water cylinder 2 1-4 inches, stroke 4 inches.

These estimates are based on your stated horsepower, and assume that you have a fairly economical simple condensing engine. If your engine is compound you will use somewhat less feed-water and will require correspondingly less condensing water, but it would not be wise to cut very much the dimensions suggested.

Q. 280.—Would you kindly answer a question for me through your Q. & A. columns?

I would like to know if there are any ferryboats on the East River, New York, that can go ahead with one paddle-wheel and back with the other simultaneously? If so, kindly give name of same, and by what company they are owned, and at what piers they land. J. D.

A.—There are no such boats in operation.

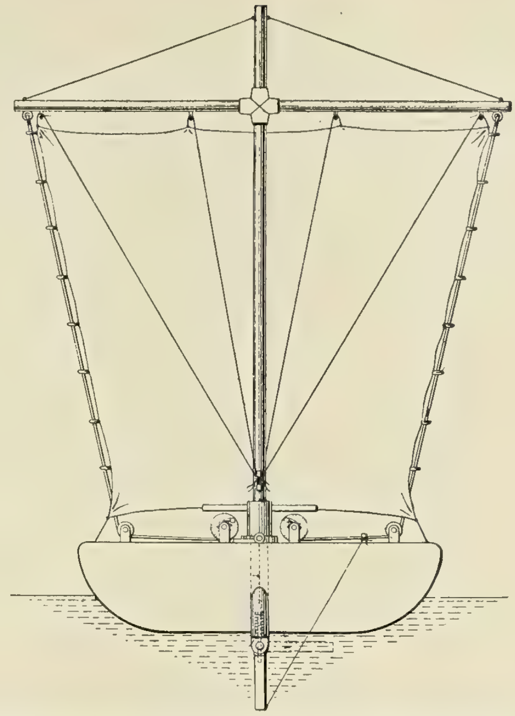
SELECTED MARINE PATENTS.

780,027. DREDGING APPARATUS. JOSEPH EDWARDS, BROOKLYN, N. Y., AND WALTER H. GAHAGAN, BOONTON, N. J.

Abstract.—The invention therefore consists, essentially, in a conical or cylindrical hood or envelop surrounding the mouth of the suction pipe and firmly connected thereto in such a manner as to provide an annular space between the suction pipe and the outer hood, said hood extending upward alongside of the suction pipe from the mouth as far as may be necessary to prevent that caving in of the materials around the mouth as will be likely to smother the suction and clog it from receiving the proper amount of water used in the process of hydraulic dredging. Two claims.

779,440. SAIL BOAT. JAMES P. POOL, BROOKLYN, N. Y.

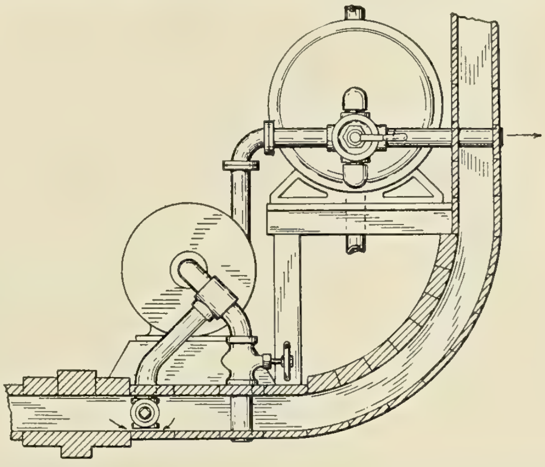
Claim.—2. A boat provided with a suitable mast, a square or wing-and-wing sail, an adjustable stay arranged at each of the side edges of said sail for trimming the sail, the said sail being provided with tackle for raising



and lowering it on the stays, substantially as and for the purpose set forth. Three claims.

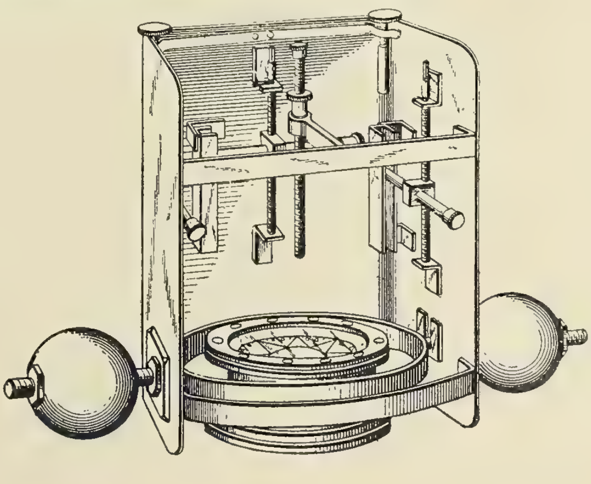
779,889. REVERSIBLE-CURRENT APPARATUS FOR CONDENSERS. JOHN TODD, SEATTLE, WASH., ASSIGNOR OF ONE-HALF TO GEORGE W. WILSON, SEATTLE, WASH.

Abstract.—This invention relates to marine condensers and circulating pumps, and more particularly to apparatus whereby the current of water passing through the condenser may be quickly reversed in order to dislodge



obstructions collected in the mouths of the condenser tubes and convey such accumulations into the outboard water-discharge pipe, and also to provide means whereby in an emergency the bilge water may be pumped directly into the said discharge pipe without having to pass through the usual channels. Two claims.

780,374. BINNACLE FOR SUBMARINE BOATS. JOHN S. NEGUS AND HERBERT BLOSSOM, NEW YORK, N. Y.

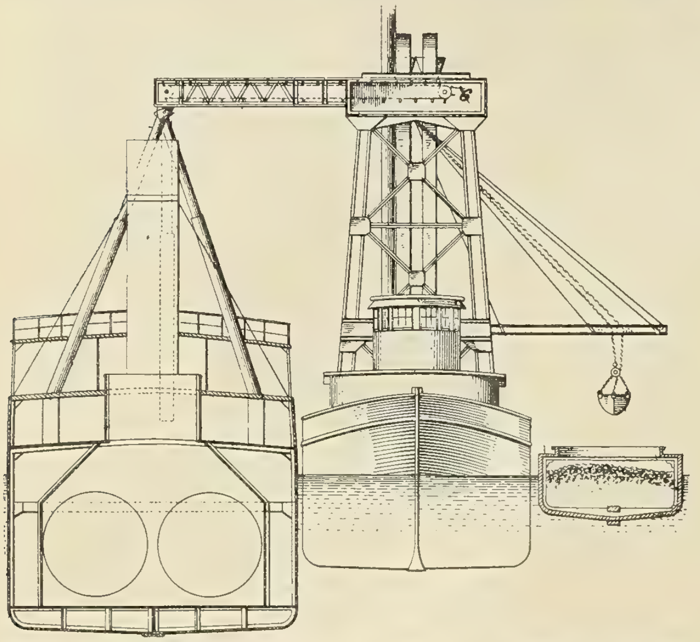


Claim.—5. A binnacle, having a compass pivotally mounted therein, horizontally disposed magnets mounted on the binnacle above the level of the compass, and means for moving said magnets toward and from the compass, said means and the magnets being mounted in a readily-removable manner and being accessible from above the binnacle.

6. A binnacle, having a casing and quadrantal correctors at respective opposite sides of same, said corrector comprising a screw-threaded rod projecting out laterally from the casing, a ball which is threaded on said rod, and means for securing said ball in place when set on the rod. Nine claims.

780,083. VESSEL FOR BUNKERING AND LOADING SHIPS. EDWARD T. WILLIAMS AND GEORGE A. ORROK, BROOKLYN, N. Y.

Claim.—1. A self-propelling, non-cargo-carrying vessel, having a supporting tower combined with a hoisting apparatus adjacent to the base of the tower for raising cargo or bunkering material lying alongside and discharging it inboard; an elevator supported by the tower and to which the discharged material is delivered and which is adapted to raise the material to a height

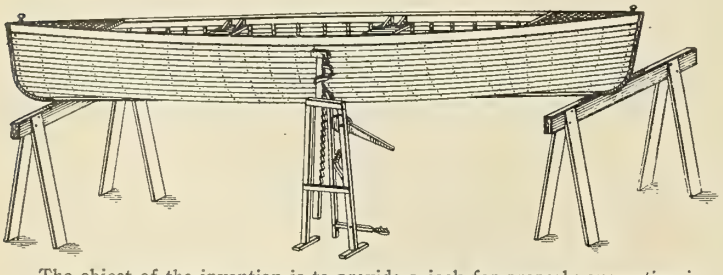


directly over said vessel less than would suffice for its descent by gravity therefrom to the farthest point that the vessel is adapted to ultimately deliver the material; an arm whose inner end rests directly upon and is secured to the upper end of the tower and whose outer end extends outward therefrom; a driven conveyer carried by said arm for taking the material delivered to it by the elevator at this height and conveying the same outboard beyond the opposite side of the said vessel to a point directly over the loading or bunkering ship; and a delivery chute leading downward from this point to the ship. Two claims.

781,052. FOLDING BOAT. LYNN S. DEAL AND ADDISON D. GUTCHES, KALAMAZOO, MICH.

The objects of the invention are, first, to produce a folding bottom or keel for boats having a flexible skin, so that the same may be folded into a compact form; second, to produce a folding boat bottom which will contain the greatest strength when unfolded consistent with lightness; third, to so construct a boat bottom that it will rest from end to end on the framework of the boat to which it is applied; fourth, to produce a folding boat bottom in which the end sections fold into the central section, so that the slats forming the end sections lie in spaces between the slats forming the central section, the slats of both sections lying in the same plane when folded. 9 claims.

781,542. BOAT-BUILDER'S RIVETING JACK. JOSEPH D. MORLEY, LAKE PLEASANT, N. Y.



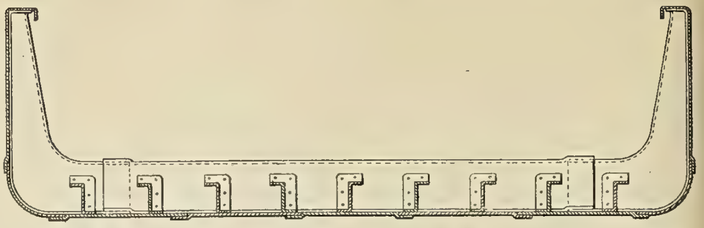
The object of the invention is to provide a jack for properly supporting in respect to the strakes of the boat the weight against which the rivets are clenched, so that the man who is driving the rivets will have both hands free. 5 claims.

782,153. BARGE OR OTHER BOAT. JAMES S. MARTIN, PITTSBURG, PA.

Claim.—1. A barge formed from pressed steel having a series of longitudinally-disposed bottom ribs, side ribs terminally attached to the outermost bottom ribs, the latter ribs having upper flanges extending over the lower ends of the side ribs and a sheathing secured to said ribs.

2. A pressed-steel barge composed of a series of bottom and side ribs, the bottom ribs being arranged in planes at right angles to the side ribs and having upper and lower angular flanges, cross-girders arranged at intervals and having enlarged terminals embracing portions of and secured to the side ribs, said girders intersecting the longitudinal bottom ribs and having the flanges of the latter secured thereto, and sheathing plates connected to the ribs.

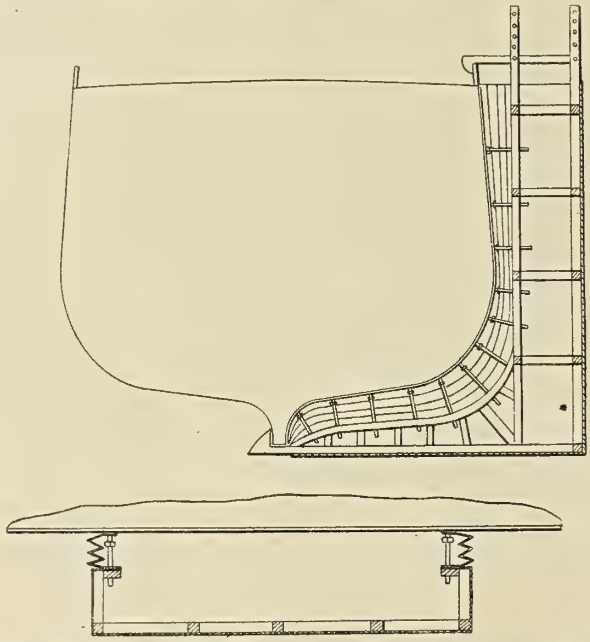
3. A pressed-steel barge composed of a series of bottom and side ribs, having end flanges, the bottom ribs being disposed longitudinally, and an outer sheathing connected to said ribs and having the upper terminal thereof bent



at an angle in relation to the upper extremities of the ribs to provide a supporting means. 3 claims.

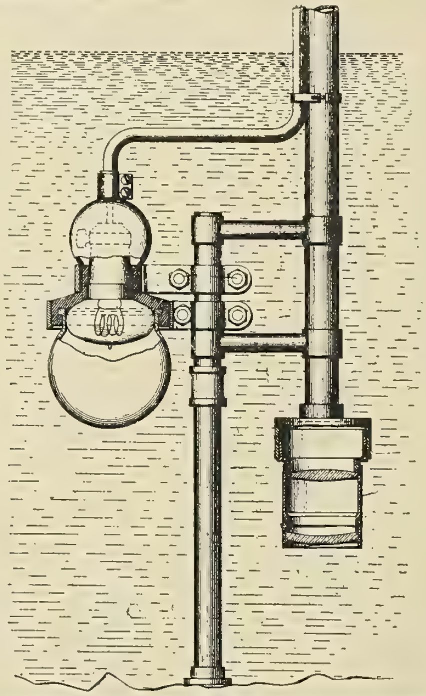
783,276. SHIP REPAIR MECHANISM. JOHN C. HUGHES, SOUTH OMAHA, NEB.

This invention has particular relation to means for permitting access to the sides and bottom of boats, ships, or vessels of any type without the neces-

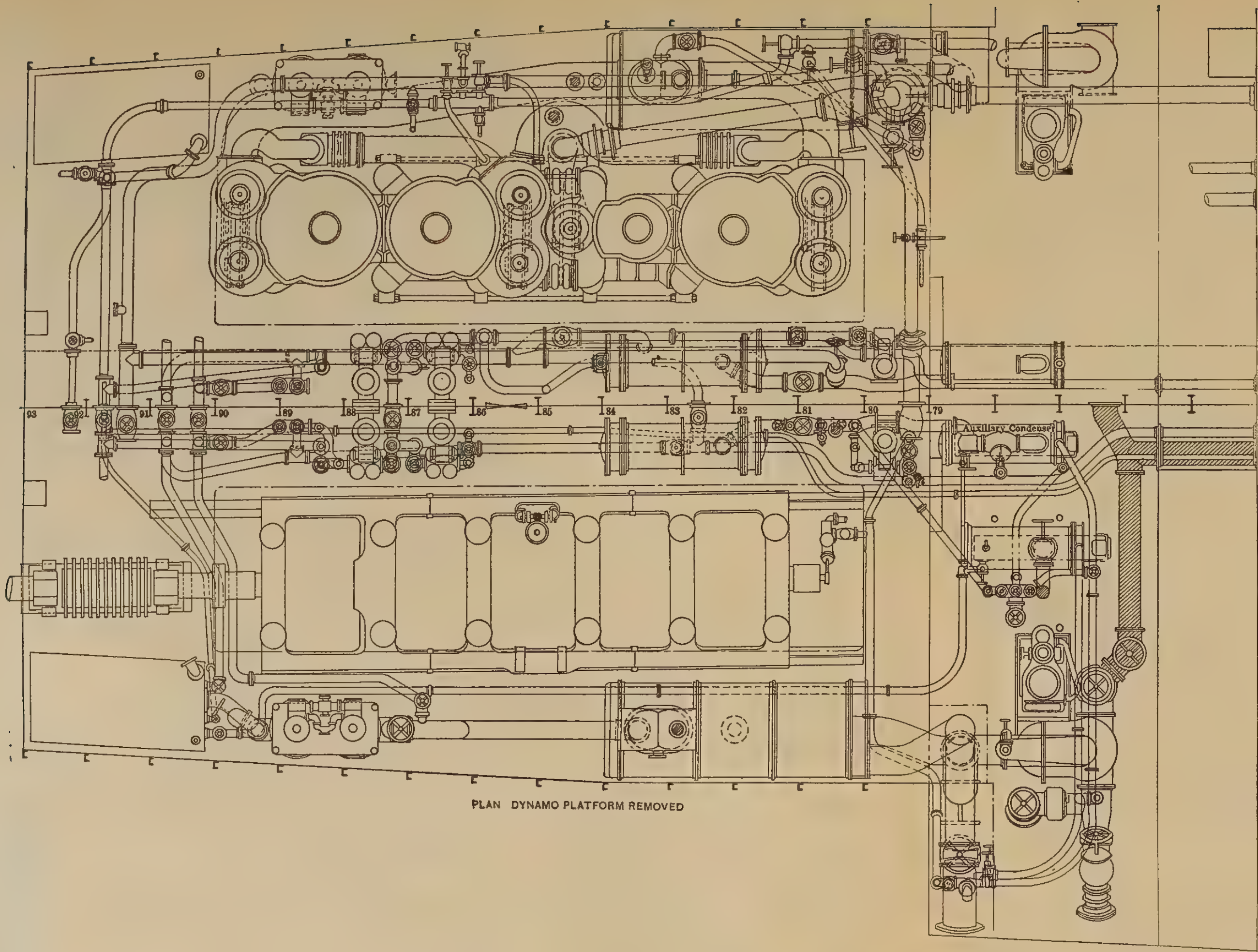


sity of removing them from the water, and consists in a caisson or removable closure capable of being attached to the sides and bottom of a vessel and means for forming a water-tight joint between the casing and the vessel, and thus making it possible to remove the water from about that portion of the vessel, so that repairs may be made. 12 claims.

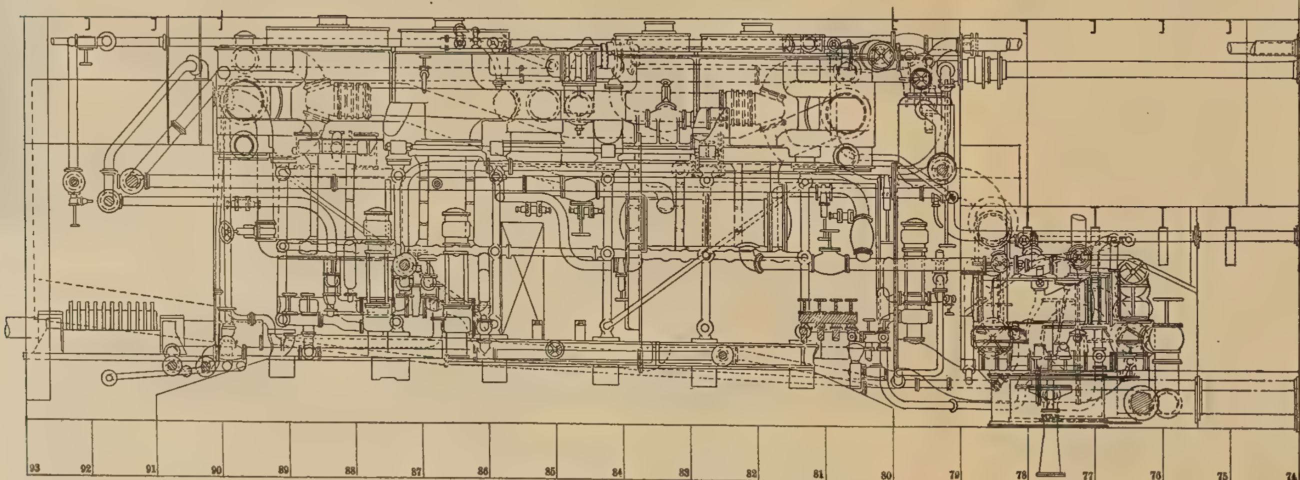
783,730. SUBMARINE VIEWING APPARATUS. FRANCIS McMAHON, SOMERVILLE, MASS.



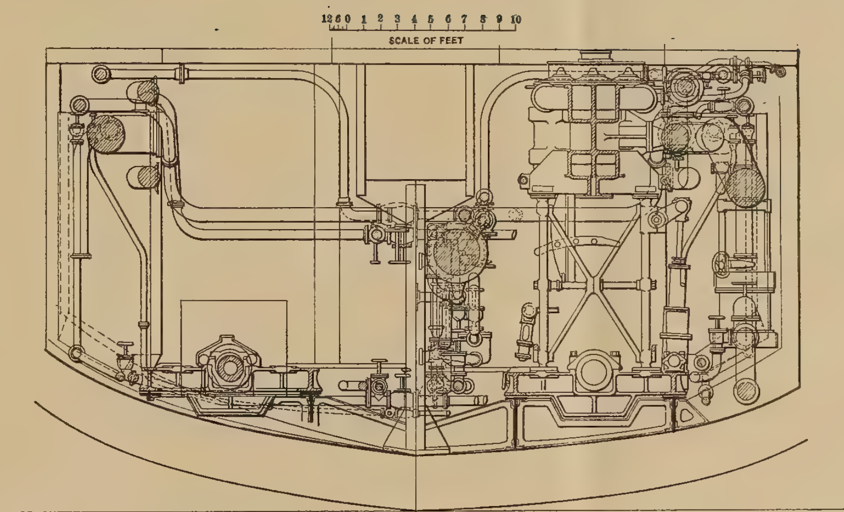
Claim.—1. An apparatus of the character stated, comprising a sight-tube provided with a lens immovable relatively to the upper portion of the tube, an electric lamp adjacent to the lens and at one side of and connected with the tube, said tube and lamp being adapted to be inserted in a body of water, and means for limiting downward movement of the apparatus, said means being located at one side of the line of sight through the tube and lens whereby a direct view downward through the tube and lens will not be obstructed by said limiting means. 3 claims.



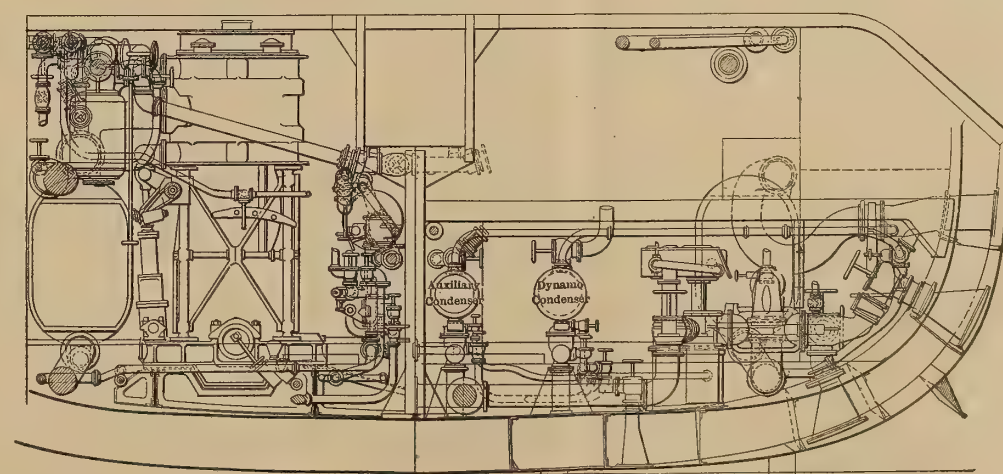
PLAN DYNAMO PLATFORM REMOVED



PORT SIDE ELEVATION, CENTRE LINE BULKHEAD REMOVED



HALF SECTION, FRAME 89 LOOKING AFT HALF SECTION, FRAME 84



HALF SECTION, FRAME 79 LOOKING AFT BULKHEAD REMOVED HALF SECTION, FRAME 75½

Marine Engineering

GENERAL ARRANGEMENT OF MACHINERY ON THE NEW UNITED STATES ARMORED CRUISERS MONTANA AND NORTH CAROLINA.

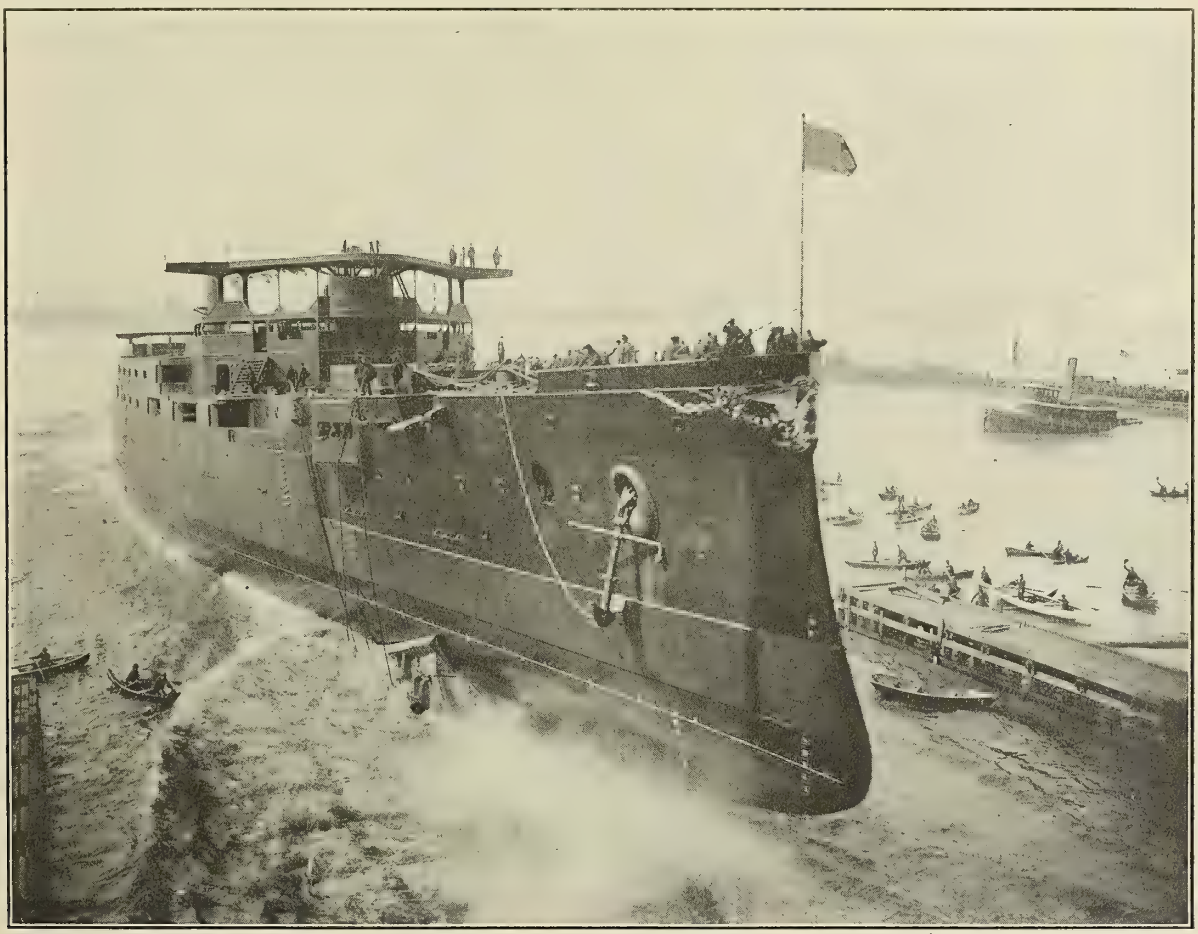
Marine Engineering

MAY, 1905.

THE LAUNCH OF THE UNITED STATES ARMORED CRUISER WASHINGTON.

On the 18th of March the New York Shipbuilding Company sent into the water the new armored cruiser *Washington*, which they are building for the United States government. The *Washington* is one of two armored cruisers whose construction was authorized by Congress on July 1, 1902. The contract for the construction of this ship was signed on the 10th of February, 1903, being one day later than the signing of the contract for her sister ship *Tennessee*, which is being built by the William Cramp & Sons' Ship and Engine Building Company, of Philadelphia. The keel of the *Washington* was laid on September 23, 1903, and the contract date of completion is August 10, 1906. The contract price for the construction of the hull and machinery is $4,035,000.

The *Washington* is a powerful armored cruiser with a trial displacement of 14,500 tons, a full load displacement with all coal and stores on board of 15,712 tons, engines designed for 23,000 horsepower, and an estimated speed of 22 knots. The length on the water-line is 502 feet, the beam 72 feet 10 1-2 inches, and the mean draft, corresponding to trial displacement, is 25 feet. The total bunker capacity of the ship is 1,762 tons, of which amount 900 tons, known as the normal supply, will be carried on trial.



THE LAUNCH OF THE WASHINGTON.

(Photo by W. H. Rau.)

The main battery is an unusually powerful one for a ship of this type, and really entitles the ship to be classed, not as an armored cruiser, but as what might be called a battle cruiser, being somewhere between an armored cruiser and a battleship. It consists of four 10-inch rifles mounted in pairs in turrets on the center line forward and aft; sixteen 6-inch, and twenty-two 3-inch rapid-fire guns, and four 21-inch submerged torpedo tubes; together with a secondary battery of twelve 3-pounder and four 1-pounder rapid-fire guns, two machine guns, two 3-inch field guns, and six Colt automatic guns.

The armor consists in a water-line belt running completely fore-and-aft and having a thickness of 5 inches; barbettes for the

10-inch guns, having a thickness of 7 inches on the exposed parts and 4 inches where protected by the water-line belt and other side armor; and turrets having a thickness of 9 inches on the port plates, 7 inches on the sides, and 5 inches in the rear.

The propelling machinery consists of two four-cylinder, triple-expansion engines, the combined horsepower being, as mentioned above, 23,000. The steam pressure at the engines is to be 250 pounds per square inch. Each engine has cylinders of the following diameters: 38 1-2 inches, 63 1-2 inches, and two of 74 inches, the stroke in each case being 48 inches. At maximum power the engines and screws will make 120 turns per minute. Each engine is located as usual in a separate water-tight compartment, and is provided with all the regular auxiliaries as required by the Bureau of Steam Engineering. There are sixteen water-tube boilers, placed in pairs in eight water-tight compartments, and served by four funnels. The total grate area is about 1,600 square feet and heating surface about 68,000 square feet, the ratio being nearly 43 to 1.

Our illustration shows the ship just as she has cleared the ways and is in process of becoming water-borne. The launching ceremony was performed by Miss Helen Stuart Wilson, daughter of ex-Senator John L. Wilson, of Washington.

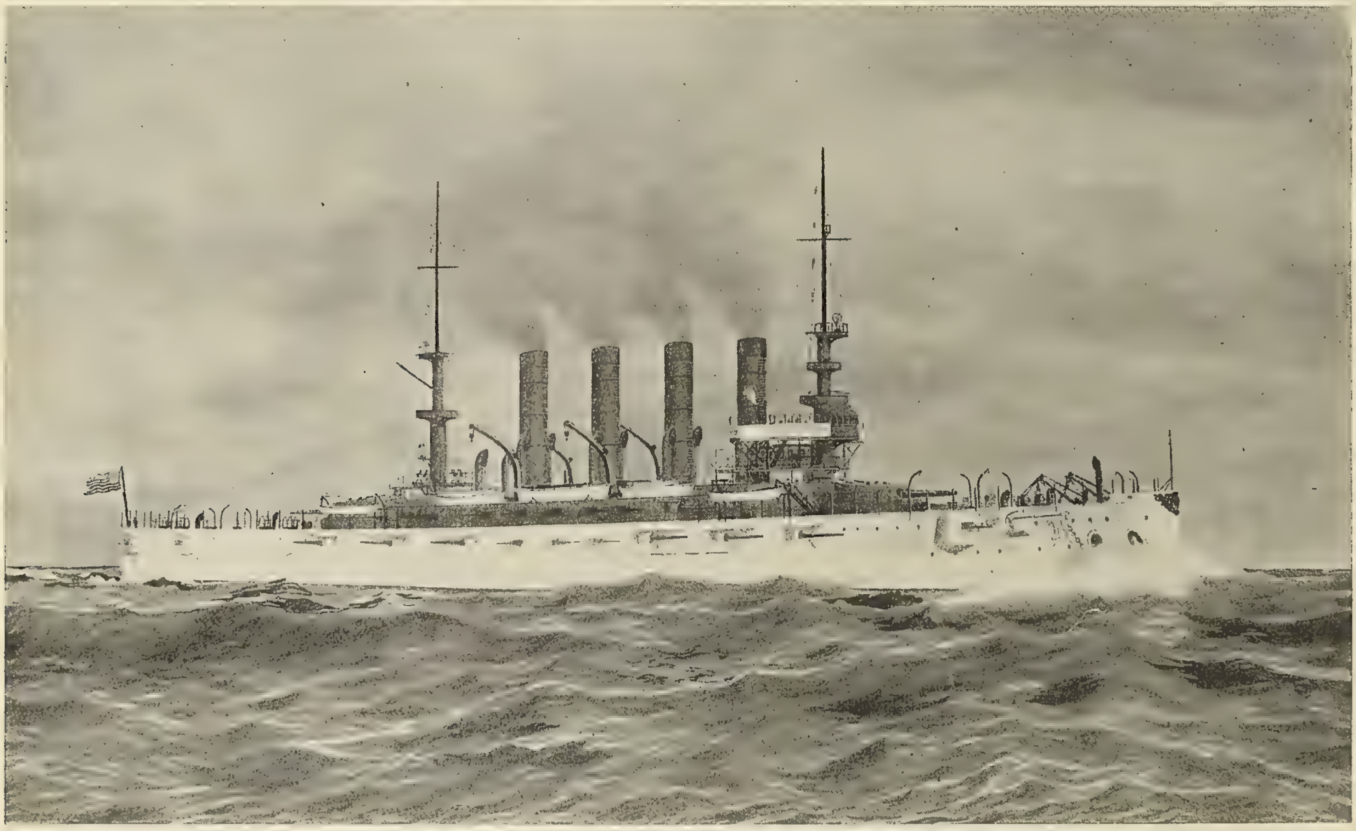
THE MACHINERY OF THE ARMORED CRUISERS NORTH CAROLINA AND MONTANA.

These two armored cruisers were authorized by Congress about a year ago, and have the following principal dimensions:

Length on load water-line	502 feet
Extreme beam	72 feet 10 1-2 inches
Mean draft, corresponding to trial displacement	25 feet
Displacement on trial	14,500 tons
Total coal-bunker capacity	2,000 tons
Coal carried on trial	900 tons

With a battery comprising four 10-inch rifles, sixteen 6-inch, and twenty-two 3-inch, rapid-fire guns, and four submerged torpedo tubes, as well as a secondary battery of twelve 3-pounder and four 1-pounder semi-automatic, rapid-fire guns, and four machine guns, these ships represent a type which is as powerful as any armored cruisers yet designed. The Newport News Shipbuilding and Dry Dock Company is under contract to build these two ships, at a cost, exclusive of armor and armament, of $3,-575,000 each.

The propelling machinery consists of two four-cylinder, triple-expansion engines of a combined indicated horsepower of about 23,000, and arranged for outboard turning propellers when going forward. The steam pressure at the engines is designed to be 250 pounds per square inch. The cylinder diameters of each engine are 38 1-2 inches for the high-pressure, 63 1-2 inches for the intermediate-pressure, and 74 inches for each of the two low-pressure cylinders; the stroke in each case being 48 inches; the number of revolutions per minute at maximum power is about 120. Each engine is located in a separate water-tight compartment, and is provided with all the usual auxiliaries in accordance with the latest practice of the Bureau of Steam Engineering. There are sixteen water-tube boilers placed in pairs in eight water-tight compartments; the total grate area being about 1,590 square feet and the heating surface aggregating 68,000 square feet; this giving

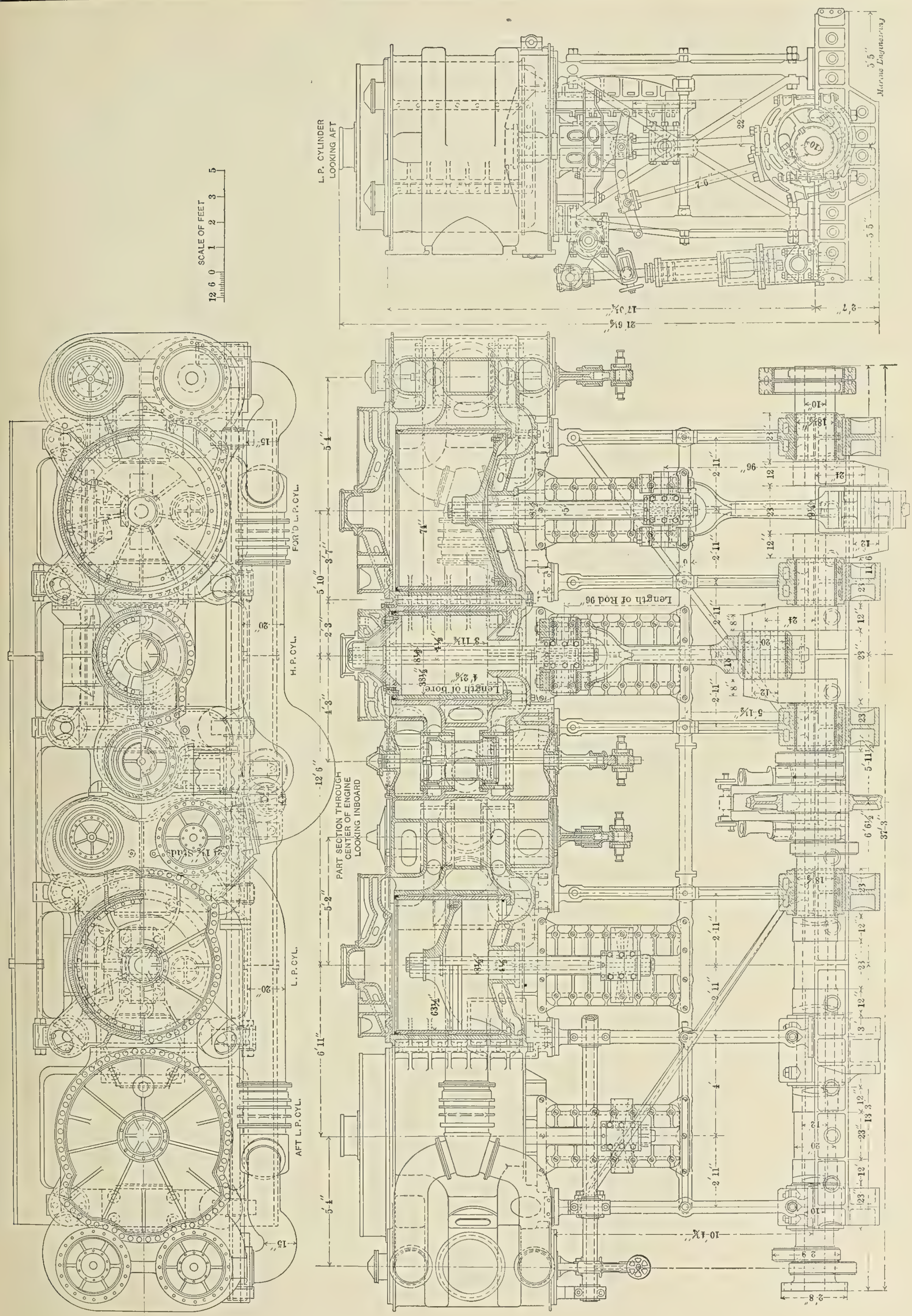


THE ARMORED CRUISER MONTANA, SISTER TO NORTH CAROLINA, WASHINGTON AND TENNESSEE.

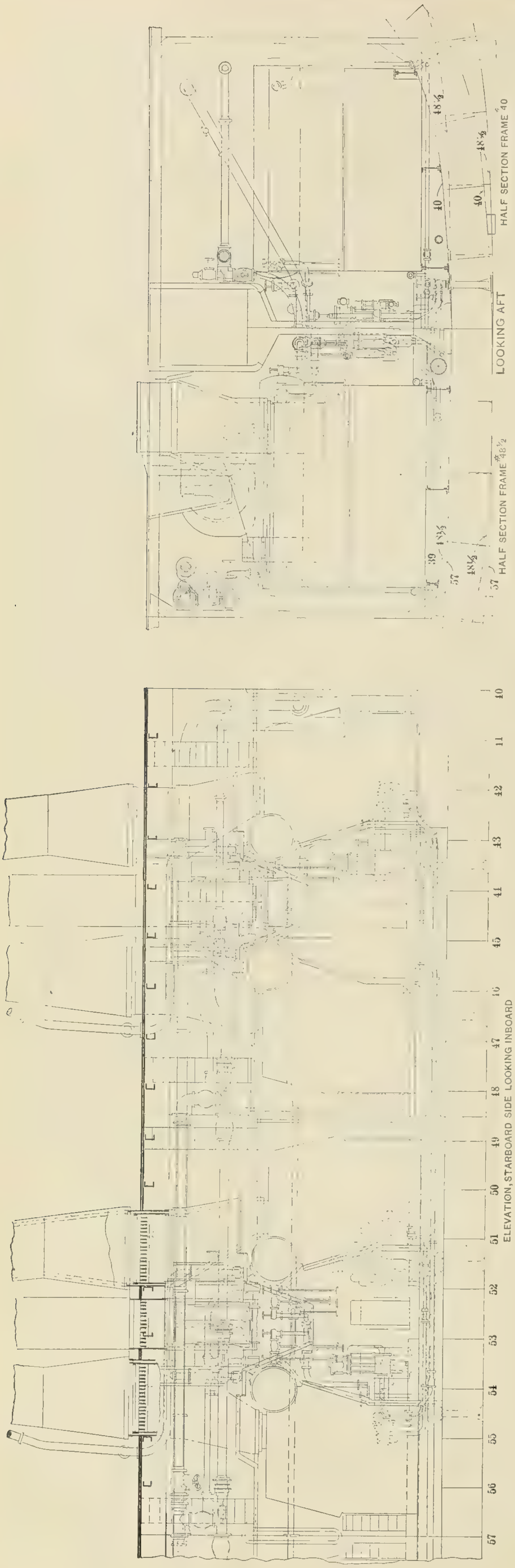
Drawn by W. R. C. Wood.

Opinion of a Gloucester Fisherman.

"I always said that them cup races, when a couple o' shingles, with junks o' led stuck on their bottoms, run around a thirty-mile triangle, with a lot o' dinky steam yachts alongside, an' a mob of old *Gen. Slocum's* with seasick landlubbers goin' along to keep them company, an' the wind blowing five knots, and the sea like a mill-pond, weren't races. They're marine circuses. For a real race, take two boats an' give them a fair test. Let them have fair weather an' foul, high wind an' low, fog an' clear, hurricanes an' gales, an' let them run a few thousand miles. Then, if either o' them is still on top of the water, the one that gets in first is the best, an' there ain't no gainsayin' it."



THE FOUR-CYLINDER, TRIPLE-EXPANSION MAIN ENGINES OF THE MONTANA.



THE GENERAL ARRANGEMENT OF THE BOILERS.

a ratio of heating surface to grate area of 42.8 to 1. The working pressure in the boilers will be 265 pounds per square inch, this allowing a gradient of 15 pounds between boiler and engine. The length of grates will be about 6 feet 10 inches, and the steaming capacity such that all steam machinery on board can be run at full power with an average air pressure in the fire rooms of not more than 2 inches of water. There are four funnels, which measure about 100 feet above the base line. Sixty-six tons of fresh water will be carried on trial in the double bottom or in reserve tanks. The weight of all machinery, tools, stores, and spare parts is not to exceed 2,060 tons.

As shown by illustration, the cylinders are located from forward aft: low-pressure, high-pressure, intermediate-pressure, and low-pressure; the distances between centers being respectively 5 feet 10 inches, 12 feet 6 inches, and 6 feet 11 inches, the cylinder axes being all in one plane and parallel to each other. The high-pressure cylinders have barrels of a thickness of 2 1-4 inches; the intermediate-pressure barrels are 2 inches thick; and the low-pressure 1 3-4. Each cylinder is fitted with a liner having thicknesses respectively 1 3-4, 1 3-4, and 1 1-2 inches, which liners are bored after being placed in the cylinders. These liners are counterbored at both ends, leaving the working bores of such length that the piston rings will over-ride 1-4 inch at the top and 1-8 inch at the bottom. The linear clearances of the various cylinders between pistons and cylinder heads will be 3-8 inch at the top and 5-8 inch at the bottom.

The high-pressure cylinders will be fitted with one piston valve of a diameter of 24 1-2 inches. Each of the other cylinders will have two piston valves of a diameter of 27 inches. These valves operate in valve-chest liners, having a thickness in each case of 1 3-8 inches.

The high-pressure pistons and followers are made of cast iron, while the intermediate and low-pressure pistons are of cast steel. Each piston has a hard cast-iron packing ring, 1 inch thick and 2 1-2 inches wide on the bearing surface, cut obliquely and fitted with a tongue, the play of the ring being limited by means of an adjustable distance piece. The piston rods are all of the same size, having an external diameter of 8 1-2 inches. They are bored to different sizes, however, the inside diameter of the low-pressure rods being 5 inches, reduced to 2 inches at the cross-head end; while the bore of the other rods is 4 1-2 inches reduced to 1 1-2. The cross-head pins are 10 3-4 inches in diameter and 11 inches long, having axial holes. The connecting rods are 96 inches long between centers, and are turned to a minimum diameter of 8 1-4 inches at the cross-head end and 9 1-4 inches at the crank end.

There will be two sections of crank shaft for each propelling engine, each section having two cranks and coupling disks, as shown in the illustration. The radius of cranks is, of course, 24 inches, and the coupling disks will have a thickness of 4 1-2 inches and a diameter of 32 inches. The journals are 18 1-2 inches in diameter and the crank pins 20 inches in diameter and 23 inches long. The crank webs are 12 inches thick and 21 1-4 inches wide, and are chamfered. A 12-inch hole is bored through each crank pin and a 10-inch hole axially through each shaft. The thrust shafts have a diameter of 17 1-2 and 17 3-4 inches with a 10 1-2-inch axial hole, and an over-all length of 24 feet 11 1-2 inches. Each shaft has 12 thrust collars 2 inches wide and 27 inches in diameter, separated by spaces of 4 inches each. The coupling disks, forged on the forward and after ends of the thrust shaft, are of the same size as those on the crank shaft, except that the diameter of the after coupling disk is 33 1-2 inches. There is one section of stern-tube shafting for each engine, supported on two stern-tube bearings, and measuring 18 1-2 inches in diameter except at the forward end, where a diameter of 20 1-2 inches has been adopted to form a seat for the forward collar of the coupling. These shafts are 52 feet long and have 10 1-2-inch axial holes, reduced in the after couplings to 7 inches. The propeller shafts are 18 1-2 inches in diameter with a 10 1-2-inch hole tapered to 7 inches at the forward end and to 4 inches in the propeller hub. These sections of shaft are about 48 feet 11 inches in length. The taper of the propeller shaft within the propeller hub is 1 inch in diameter per foot of length.

Each crank shaft has six bearings, of which five are 23 inches long, and the fifth, counting from forward, is 36 inches long. The stern-tube bearing in each case consists of a composition bushing made in halves, and fitted with sections of lignum-vitæ, so placed as to wear on the end of the grain, and held in place by flat rings. The bearings in the struts and stern brackets will also be lined with lignum-vitæ.

There will be two main condensers, one for each engine, and each having a cooling surface measured on the outside of the tubes of about 14,400 square feet. These condensers are oval in form and measure about 9 feet 4 inches high and 5 feet 8 inches wide. The shell has a thickness of 5-16 inch with double butt joints and with circumferential and longitudinal stiffening. Each condenser contains 6,292 seamless drawn tubes 5-8 inch outside diameter, 14 feet long between tube sheets and spaced 15-16 inch between centers; the thickness of the metal in these tubes is No. 16 B. W. G. The tubes are formed of a composition consisting of copper, 70; tin, 1; and zinc, 29 percent. Auxiliary condensers are fitted in each engine room for taking care of the exhaust from all of the auxiliary machinery and have each a cooling surface of about 600 square feet. Dynamo condensers in the dynamo room have each a cooling surface of about 700 square feet.

The main air pumps are two in number, one for each condenser, and are double, vertical, and single-acting, with two inverted steam cylinders. The diameter of the steam cylinders is 14 inches; of the air-pump cylinders, 35 inches; and the length of the common stroke, 18 inches. The suction and discharge openings have diameters 13 and 11 inches respectively. There are two main circulating pumps, each driven by an independent compound engine, and having sufficient capacity to discharge 15,000 gallons of water per minute, at a speed of revolution not exceeding 265. The suction and discharge nozzles have openings equivalent in area to that of a circle 21 inches in diameter.

The main steam pipes, which are of seamless drawn steel, are arranged symmetrically in two systems, one on each side of the ship. An 8-inch branch pipe will lead from each compartment of two boilers. These 8-inch branch pipes will take steam directly from the auxiliary steam pipes, and so indirectly from the boilers. The branches from the forward two compartments will unite into an 11-inch pipe, the diameter of which will be increased at successive junctions to 12 inches and to 13 inches. The auxiliary steam pipes are 8 inches in diameter and extend fore-and-aft from the boiler compartments, one on each side of the ship. Each auxiliary steam pipe connects with the main stop valves of all boilers on its own side of the ship through 5 1-2-inch branches.

Before being placed on the vessel the boilers will be tested to a pressure of 400 pounds above the atmosphere; the high-pressure cylinders, jackets, valve-chests, and connections, as well as all steam pipes and valves subject to boiler pressure, and the evaporator tubes, will be tested to the same pressure of 400 pounds per square inch. The feed-water heaters on discharge side of pumps, the feed-pump water cylinders, valve chests, and air vessels, will be tested to 500 pounds; the fire and bilge-pump water cylinders, valve-chests, and air-vessels will be tested to 225; the intermediate-pressure cylinders, jackets, valve-chests, and connections to 200 pounds; the low-pressure cylinders, and the feed-water heaters on the suction side of the pumps to 100 pounds; the evaporators and distillers to 50 pounds, and the condensers and exhaust valve-chests of the low-pressure cylinders to 30 pounds.

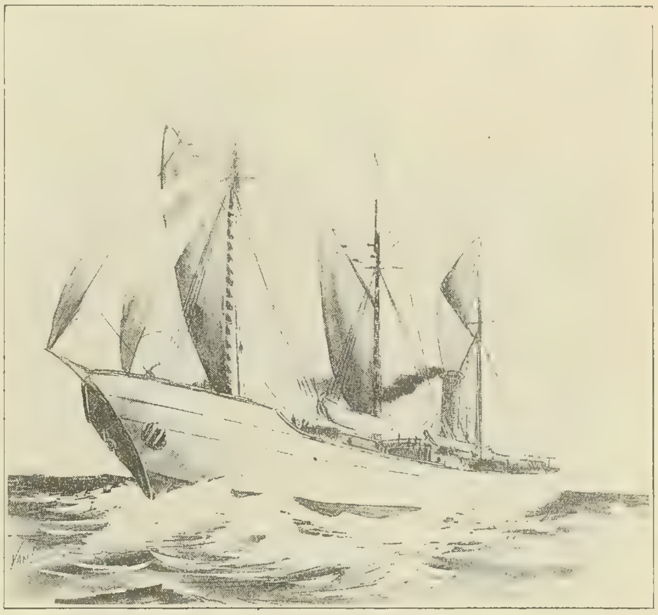
The old wooden frigate *Hartford,* Admiral Farragut's flagship at the battle of Mobile Bay, in the Civil War, has seen her last sea service, and after repairs at the Norfolk navy yard will be placed on the list of historic naval vessels and sent as permanent station ship to the Annapolis naval academy. She was illustrated on page 107 of our March number.

PEARY'S LATEST ARCTIC SHIP, THE ROOSEVELT.

Peary's new Arctic ship, the *Roosevelt,* now receiving her machinery and finishing touches at Portland, Me., preparatory to being brought to New York for fitting out in the fore part of June, is a remarkable craft, unique in part, and at the same time combining all the experience of Arctic craft to date. The *Roosevelt* is now about 70 percent complete, and we are able to give our readers the first authentic description of this vessel together with the design plans.

In his latest, and what is to be his final effort to reach the North Pole, Commander Peary has united the fruits of his own experience in the past, together with the difficulties which have confronted his rivals in this forbidding, albeit fascinating field of geographical research.

This last Arctic ship is naturally very remarkable in many ways. Physical hardiness and a determined spirit to buck against the seemingly insuperable difficulties presented by the icy barriers of the Far North are not enough, as the past has proved, to reach the North Pole. The prime question, even despite the intense cold, is one of provisioning; and successful provisioning demands that supplies be carried to the North to the utmost limits of navigation and in sufficient quantity to last at least two years.



THE ROOSEVELT AT SEA.

To carry so large a mass of stores into and through the many obstructive leagues of dodging ice floes in a minimum coal consuming vessel, calls for a craft of peculiar qualities. The vessel must be large enough to carry a coal supply that will insure her steaming endurance through months of isolation from the coal heaps of civilization. She must be able to carry all of the edible supplies, clothing and special equipment demanded by her personnel. She must carry spare parts and ship's stores enough to last for two years, for this rigorous work calls for continual repairs, which are at times vital to the welfare of the entire expedition. Finally, the craft must be strong enough to pound, pound and pound for months at a time against the ice-bound channels of that inhospitable region. Experience has demonstrated that the sturdy whalers, stout as they are, are not strong enough for this persistent attack, and, to provide for this almost disheartening work, this new ship was especially designed and constructed. All that the cunning of past experience and the acme of the art of ship construction in wood can accomplish is combined in Peary's new ship, in form of hull, structure, machinery, rig and outfit.

The model of the hull is rather bluff, and lies fairly low in the

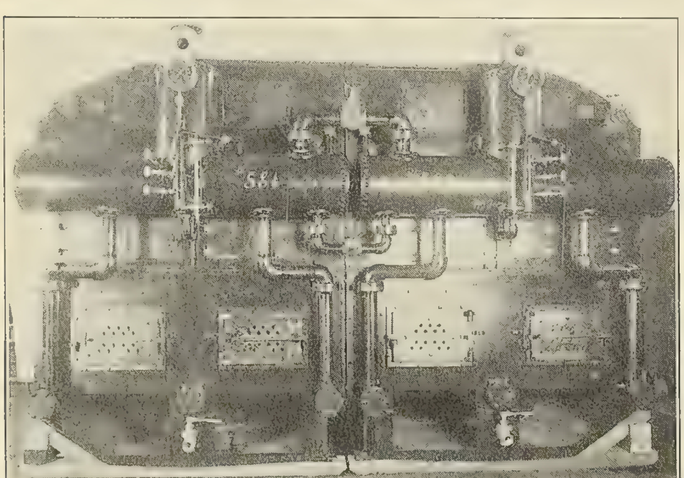
LAUNCH OF THE ROOSEVELT.

(Photograph by J. O. Whittemore.)

water, and is suggestive both of strength and capacity. Probably in no part of the world can be found a model or form of hull similar to this vessel, whose mission is to drive into, break down and force away the ice fields in front, with a stern so shaped that the over-hanging portion will more or less protect the screw when the heavy ice floes come together against the vessel's quarters. There is no "tumble-home" of the top sides such as may be found in former Arctic vessels, but instead, the top sides "flare out" up to the rail, which admits of working a very heavy guard strake.

The purpose of this guard strake, apart from being a buffer, is to help to lift the vessel out of the water as the ice crushes about her. As can be seen, the ice will press against her sides, and then, as they offer first resistance, it will rise and catch under the counter or over-hang of this guard and bodily raise the vessel. In case the ship, on the other hand, has been frozen in a thick pack of ice, and it is desirable to free her, hydraulic jacks are set upon the ice and brought to bear upon the under side of the guard, and these, in turn, will raise the craft, and as she is permitted to settle back, her own weight and her form, acting as a big wedge, will tend to break a way clear. This is a peculiarly novel arrangement.

Reference to the midship section and the lines will show the combination in form of the old time "frigate floor," and the modern ferry-boat bilge, which, together, gives a body that will admit of the vessel's laying-over on her side without damage, and also gives what is known in ship parlance as a "freeing-section" from lateral compression of ice from without.



THE ALMY BOILERS OF THE ROOSEVELT.

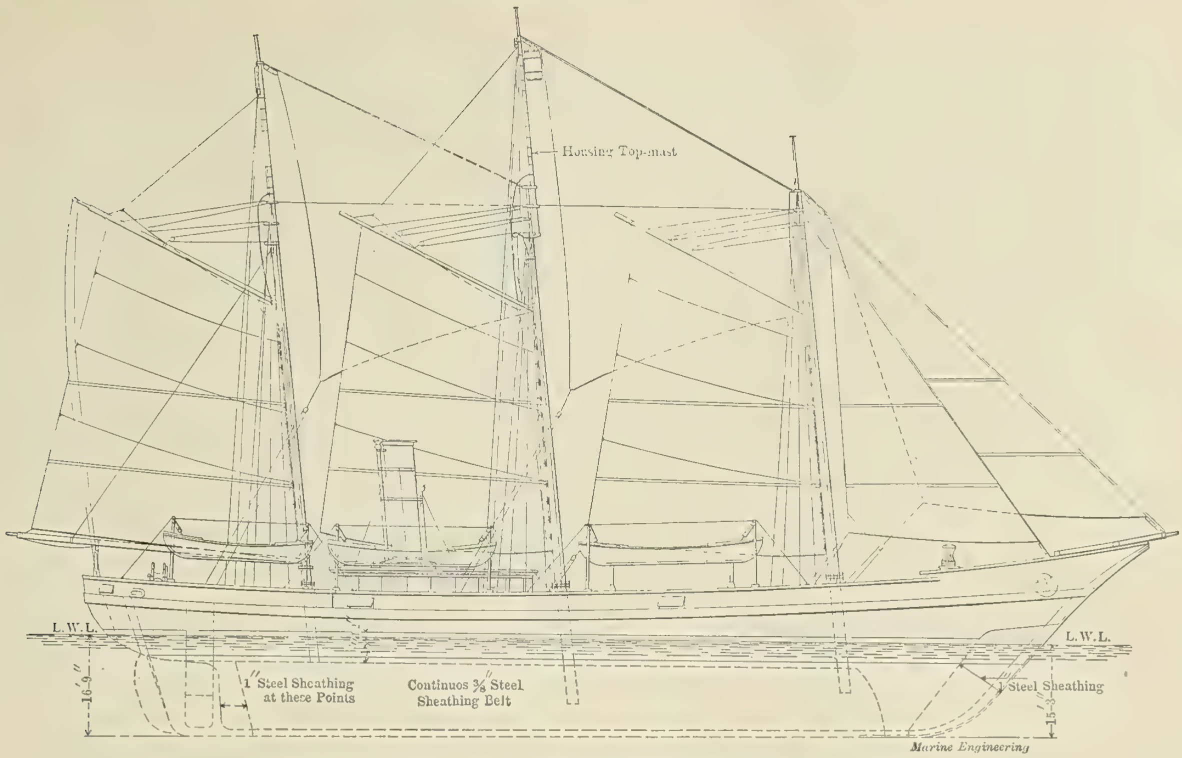
The most important feature of this vessel's form is the bow and forefoot. This is designed so that, when driving into thick ice, the vessel will ride upon the ice and break it down, and at the same time keep the broken ice from piling so high as to be an impediment to the next ramming. The extreme flare of the bows from the water-line to the forecastle deck is also for this purpose. Of the form indicated above, braced, girded and re-enforced as never was craft before, she will be able to withstand enormous pressures from surrounding fields of ice. This squeeze of the ice will tend to lift rather than to crush her in the grasp of the gathering pack. The extreme ferry-boat form of midship section will raise her higher out of the ice, the harder the squeezing becomes.

The vessel is technically described as a "three-masted, fore-and-aft, schooner-rigged steam vessel, with auxiliary sail power," larger than Nelson's famous *Fram*, but about the size of the Antarctic ship *Discovery*. There the similarity ceases, and, in order that our readers may have a better notion of the bulk and build of this unique craft, we give her principal dimensions, as follows:

Length on load water-line (between perpendiculars).	161 ft. 0 ins.
Length on deck (about)	172 ft. 0 ins.
Length over all, from tip to tip of rail (about)	182 ft. 0 ins.
Breadth, molded (to outside of plank at deck beam).	33 ft. 0 ins.
Breadth to outside of plank at load water-line	32 ft. 0 ins.
Breadth, extreme, over guard	34 ft. 2 ins.
Depth, molded (from top of main-deck beam at side to bottom of keel at midship frame)	20 ft. 0 ins.
Draft, forward	15 ft. 3 ins.
Draft, aft	16 ft. 9 ins.
Mean draft, amidships	16 ft. 0 ins.

Her displacement, when ready for sea, and with all coal and stores aboard, will be about 1,500 tons.

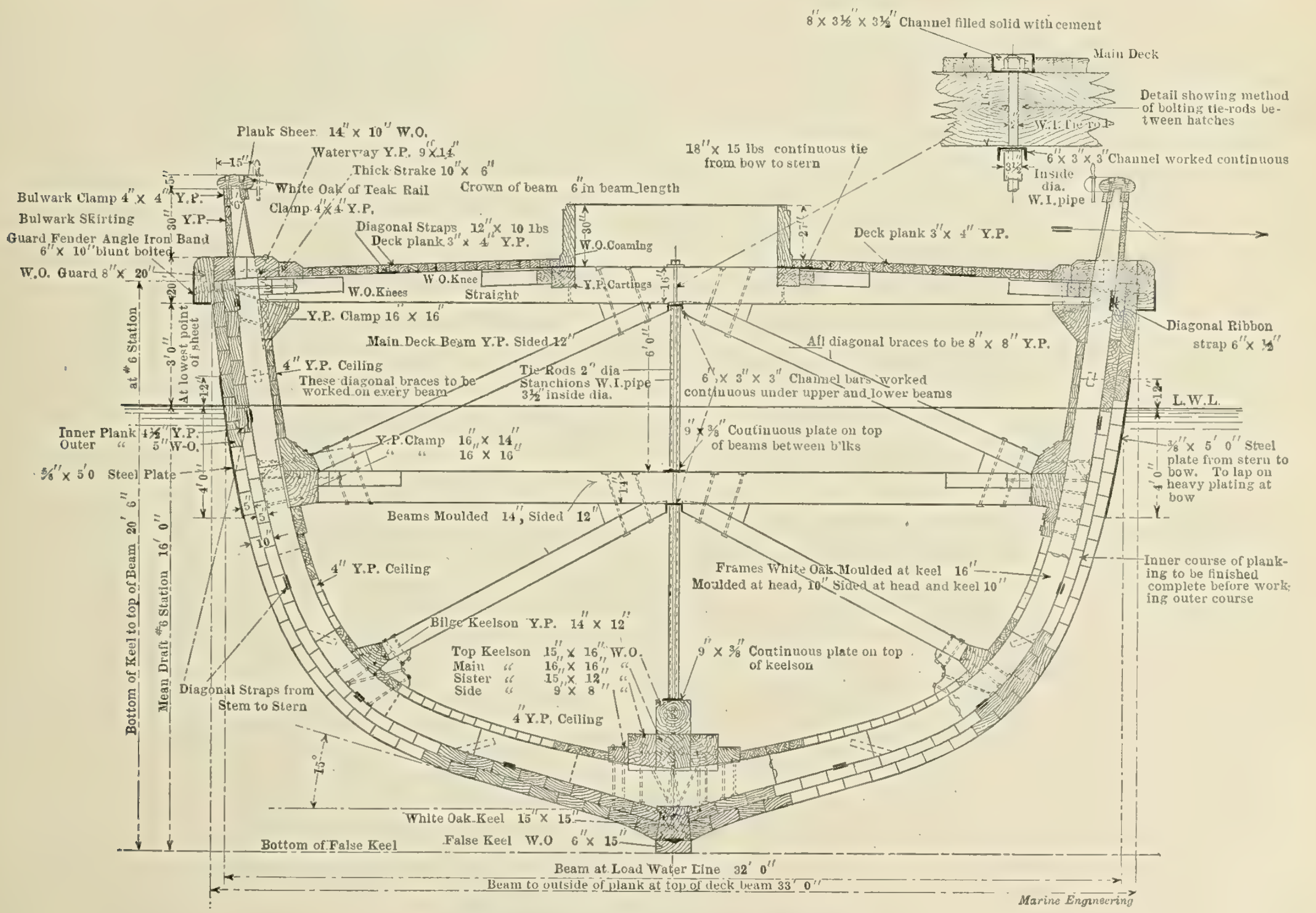
Continuity of strength, fore and aft, laterally and vertically, has been considered in view of the work to be accomplished, as may be noticed from the midship section and inboard profile. When it is considered that the bow framing extends ten feet aft of the stem of solid dead wood, some idea of the terrible pounding this vessel will be able to stand can be appreciated. This solid framing is from the natural white oak crooks, and is bolted from all directions. In addition to this heavy framing, a three-quarter-inch vertical apron plate is worked inside of all to prevent the forward



SAIL PLAN AND OUTBOARD PROFILE OF THE ROOSEVELT.

hood-ends of the double planking from starting during the continual ramming into the ice.

Compared with the United States government revenue cutters *Bear* and *Alert*, and with Arctic whalers of recent years, the *Roosevelt* is a much stronger vessel throughout. She is double-framed and double-planked with two courses of five-inch oak plank, and ceiled on the inside of the frame with three-inch yellow pine ceilings. In addition to this heavy framing, big 14-inch by



MIDSHIP SECTION SCANTLINGS OF THE ROOSEVELT.

12-inch 'tween-deck beams are worked in every frame at the water-line to prevent lateral crushing of the vessel. Between the main deck and the 'tween-deck beams, heavy athwartship diagonal braces are worked to keep the vessel from being crushed from the bilges upward. The longitudinal strength is maintained in each side by very heavy oak and yellow pine keelsons, clamps, stringers, deck plank and inside and outside planking, all of which is copper bolted in all directions.

To take up any vertical working of the vessel that may occur from months and months of forging into and breaking down the ice, heavy wrought iron tie-rods are fitted from the lower side of the main keel to the top of the deck beams. These tie-rods are run through wrought iron pipes (which act as beam stanchions) and they may be "set up" at will on the main deck.

To take the rub and grind of the floating ice, the bow, the sides along the water-line, and the stern, are protected by steel plating. At the stem this plating, an inch thick, reaches from the keel all the way up to about six feet above the load water-line, and extends aft from the stem for quite twelve feet. This is for protection of the bow when ramming. The water-line plating, which is three-eighths of an inch thick, is a continuous belt five feet wide, one foot above water, and four below. The fact that this steel plating should be required to reinforce the unusually heavy double course of planking is significant of the tremendous wear and tear to which a craft in the Polar seas is subjected.

The sails, which are unusual in form, have sufficient spread to make the vessel thoroughly manageable in case of breakdown of the machinery. They will be used on all occasions to help save coal, and to speed the vessel on her journey northward. The sails will be of heavy canvas and so fashioned that they will be able to stand frequent freezing and thawing, and the driving blast of the Polar region. The arrangement of sail, too, will admit of easy handling by a few men. The rigging, which is not fully indicated in the accompanying cuts, is of the best wire rope, payed all over, and of very heavy scantling. As soon as the vessel reaches the Polar regions she will be stripped of bowsprit and fore and mizzen topmasts, leaving the main topmast only, for the "crow's nest," which is carried at the mast head of the main topmast, from which a lookout will direct the navigation of the craft, when once she has entered the ice floes.

Speed is not the aim of her power, but instead it is intended to enable her to pound her way, day in and day out, through the great ice floes that will surely lie between her and her goal, so that the bunker capacity is for something like 600 tons of coal, which, economically used, should suffice for many months of steady work.

The vessel is heated by steam, but it is not the present intention to light her by electricity, as the heat of oil lamps, not to mention their economy, serves to add that much more to the comfort of her living spaces.

The topgallant forecastle carries the bow high enough to make the vessel reasonably dry in a head sea, while affording space for the accommodation beneath of the Eskimos and their dogs, which will be housed there later on.

The two big deck houses will provide quarters for Commander Peary, the ship's officers, and the members of the scientific staff, including the picked crew of about twenty men. The houses are of peculiar construction and will be portable, the object of this being to enable their removal from the ship to shore if emergency demands, where they may be turned into reasonably comfortable habitations susceptible to economical heating and maintenance. The living quarters are comfortably and substantially finished, but there is no attempt at decoration. The prime aim is utility, and security against the searching winds of the Far North, without adding to the task of keeping everything clean and sanitary. Special provision has been made for the installation of all scientific instruments, and space enough is provided for a small and select library of scientific works, together with a reasonable quantity of general reading matter.

The *Roosevelt* will carry six whale boats. When the Polar region is reached, these boats will be carried in athwartship skids, just forward of the mainmast, and will all be fitted with runners so that provisions can be transported over the ice in establishing the cachés at various points, after the vessel has reached a point where the solid ice prevents her further progress north.

For motive power the vessel has a single engine of the compound condensing type, designed for the economical development of 1,000 indicated horsepower; while, when occasion demands, such for instance as bucking a floe, the engine will be able to develop between 1,400 and 1,500 indicated horsepower.

The vessel will carry a number of ten-foot propellers, all being so arranged that they may be disconnected from the shafting and hoisted up into a well when the vessel is under sail, or when, to guard the propeller against the ice when the vessel is not ramming, it is desirable to house it. With the steam power at her disposal, the ship should be able to make quite twelve knots per hour under the normal development of her power, and with her maximum of 1,500 indicated horsepower, she should make fourteen or fifteen knots. The cost of her hull and machinery, complete, will be about $125,000, about $50,000 of this sum being absorbed by her motive power.

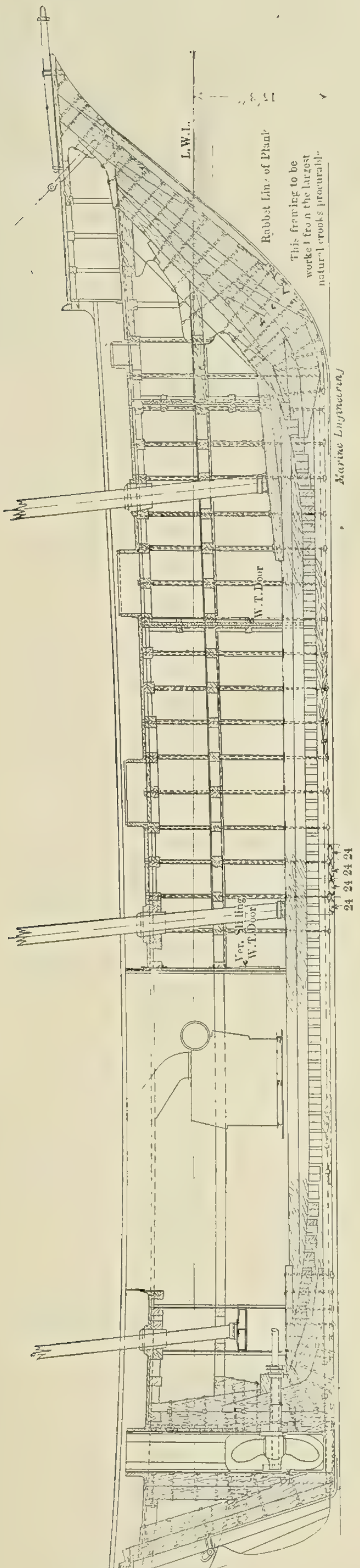
The vessel was designed by William E. Winant, naval architect, of Washington, D. C.; the hull was built by McKay & Dix, of Bucksport, Me., the machinery is being installed by the Portland Company, of Portland, Me., and the boilers are from the shops of the Almy Water-Tube Boiler Company, of Providence, R. I.

The funds for building the *Roosevelt* are from voluntary contributions, and have been furnished entirely by the Peary Arctic Club of New York.

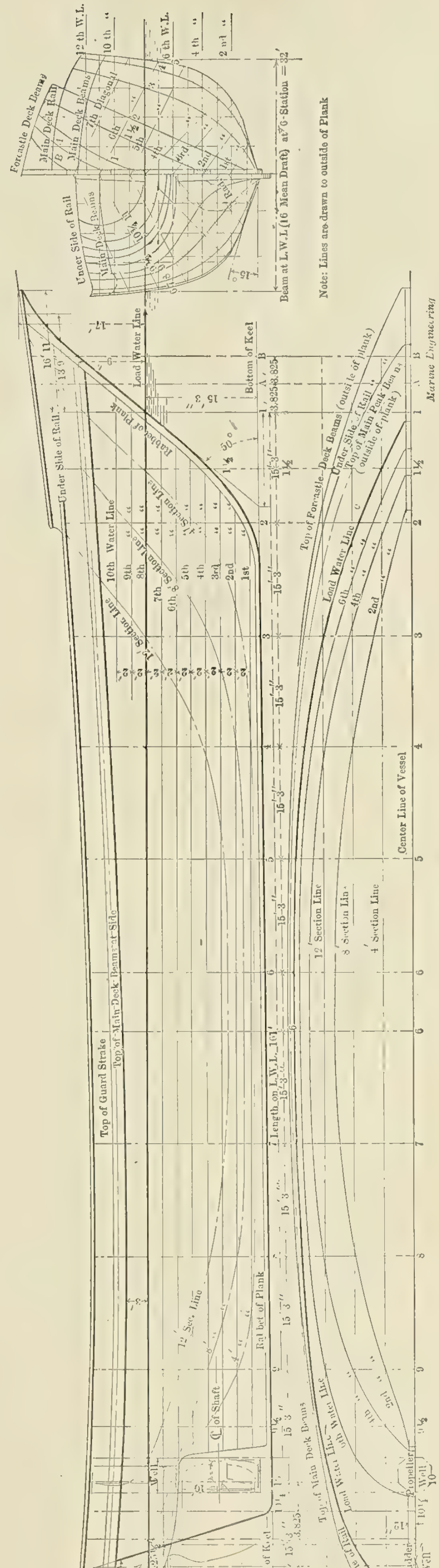
Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, report under date of April 10, 1905, the following percentage of completion of vessels building for the United States Navy:

			Mar. 1.	Apr. 1.
BATTLESHIPS.				
Virginia	19 knots.	Newport News Co.	80.82	83.74
Nebraska	19 "	Moran Brothers Co.	67.59	69.31
Georgia	19 "	Bath Iron Works	75.09	76.44
New Jersey	19 "	Fore River Shipbuilding Co.	77.9	79.4
Rhode Island	19 "	Fore River Shipbuilding Co.	82.5	84.
Connecticut	18 "	Navy Yard, New York, N. Y.	67.17	70.24
Louisiana	18 "	Newport News Co.	69.54	71.9
Vermont	18 "	Fore River Shipbuilding Co.	38.8	43.4
Kansas	18 "	New York Shipbuilding Co.	43.5	48.1
Minnesota	18 "	Newport News Co.	58.69	61.76
Mississippi	17 "	Wm. Cramp and Sons	22.55	24.39
Idaho	17 "	Wm. Cramp and Sons	19.98	22.27
New Hampshire	18 "	New York Shipbuilding Co.	0.0	1.5
ARMORED CRUISERS.				
West Virginia	22 knots.	Newport News Co.	99.75	99.95
California	22 "	Union Iron Works	72.2	73.5
Maryland	22 "	Newport News Co.	97.5	99.
South Dakota	22 "	Union Iron Works	69.5	71.3
Tennessee	22 "	William Cramp and Sons	65.14	69.45
Washington	22 "	New York Shipbuilding Co.	66.4	70.2
North Carolina	22 "	Newport News Co	0.53	2.15
Montana	22 "	Newport News Co	0.55	2.01
SEMI-ARMORED CRUISERS.				
St. Louis	22 knots.	Neafie and Levy Co.	58.8	60.6
Milwaukee	22 "	Union Iron Works	68.	69.8
Charleston	22 "	Newport News Co.	92.02	92.56
GUNBOATS.				
Dubuque	12 knots.	Gas Engine and Power Co.	88.2	90.9
Paducah	12 "	Gas Engine and Power Co.	78.6	82.8
TRAINING SHIPS.				
Cumberland	Sails	Navy Yard, Boston	94.	95.
Intrepid	"	Navy Yard, Mare Island	86.	95.
TRAINING BRIG.				
Boxer	Sails	Navy Yard, Portsmouth	98.	99.5
TORPEDO BOATS.				
Stringham	30 knots.	Harlan and Hollingsworth	99.	99.
Goldsborough	30 "	Wolff and Zwicker	99.	99.
Nicholson	26 "	Lewis Nixon	99.	100.
O'Brien	26 "	Lewis Nixon	99.	99.



INBOARD PROFILE OF THE ROOSEVELT.



LINES OF THE ROOSEVELT.

THE STABILITY CALCULATION FOR A MODERN SAILING YACHT.

Any extended discussion of the theory of approximate integration for volumes, or for finding centers of buoyancy, or of the theory of stability, is obviously out of the question in the limited space available. In this discussion we must, therefore, assume a general acquaintance with the usual methods for the determination of displacement, centers of buoyancy, and stability, and from this point of departure develop such modifications or special applications as are best suited to the treatment of the case in hand.

We first assume the half breadth and body plans at hand, the former showing the water-lines, the latter the sections. Volume or displacement alone may be found with equal readiness from either plan, while the half-breadth plan has advantages for the determination of centers of buoyancy, and the body plan for stability. The mode of procedure will depend primarily on whether a planimeter is at hand or the work must be done by means of ordinates. The chief point of difference between the case of a sailing yacht and a ship of the normal form lies in the fact that in the former the water-lines are for the most part all of different lengths, while in the latter they are for the most part of the same length. While this fact introduces some complication into the use of ordinates it makes no difference whatever with the use of the planimeter, and we may therefore proceed in the regular way for volumes and centers. The point of first attack will be the area of the water-lines. If the planimeter is of the rolling type this may be done by a single operation on each water-line as given on the half-breadth plan. If, however, the planimeter is of the polar type it will presumably be impossible to take in an entire water-line area at one operation. In such case two ways are open:

(1) The water-line areas may be taken in parts, including as great a length each time as the instrument will allow, and then summing the results.

(2) The water-lines may be redrawn, shortened up in length, and, if desired, broadened out in width. Such a distorted water-line is shown in Fig. 1. This is simply a representation of the water-line with different scales in the two directions, fore and aft and transversely. In this manner the entire half-breadth plan may be redrawn in such shape as to permit of treatment by the planimeter, each water-line at a single operation with the planimeter.

A word at this point regarding scales and the transformation of the planimeter readings with actual areas may be of use.

As a rule it will be preferable to set the planimeter so that the readings will be in square inches of area on the drawing board.

Let a be the area read from the instrument in square inches.

Let A be the corresponding actual area on the boat.

Suppose the drawing first to the same scale in both directions and $\frac{1}{n}$ inch to the foot, or 1 inch $= n$ feet.

Then we shall have:

$$A = n^2 a.$$

Thus if $a = 8.23$ square inches, and the scale is 1-4 inch to the foot, then $A = 16 \times 8.23 = 131.68$ square feet.

Again, suppose the water-lines are distorted by shortening up and widening out, so as to make possible the circuit of the entire area at one operation by the planimeter.

Let the scale fore and aft be $\frac{1}{h}$ inch $=$ 1 foot, and transversely $\frac{1}{k}$ inch $=$ 1 foot; or 1 inch $= h$ feet fore and aft, and k feet transversely. Then if $a =$ area read by planimeter, and $A =$ area on boat, we have:

$$A = h\,k\,a.$$

Thus, if the scale fore and aft is 1 inch $=$ 16 feet, and transversely 1 inch $=$ 2 feet, and if $a = 11.2$ square inches, then $A = 2 \times 16 \times 11.2 = 358.4$ square feet.

In this manner then we may find the areas of the successive half water-lines from the bottom of the keel upward to the successive immersions or drafts, and quite independently of their varying lengths and of the difficulty of treating such a case by the use of ordinates by the usual rules.

Then multiply each of these areas by 2, and plot as in Fig. 2, giving a curve of full water-plane areas. Then proceed with the planimeter to measure the area between the curve and the axis OY up to any water-plane, as YB, marking the deep load-line or the deepest draft for which the displacement is desired. Lay off the result to any convenient scale as an ordinate YB. Then find similarly the areas up to a series of water-lines 17, 16, 15, etc., down to 3 or 4, below which the values will be of no ultimate use. All such areas are then to be laid off as ordinates to the same scale as YB, and each on its own water-line, thus giving the curve OB as shown. This will be a curve of volumes and it will be only necessary to multiply any ordinate of this curve by a suitable factor in order to find the corresponding displacement.

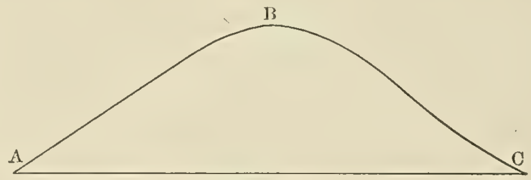


Fig. 1

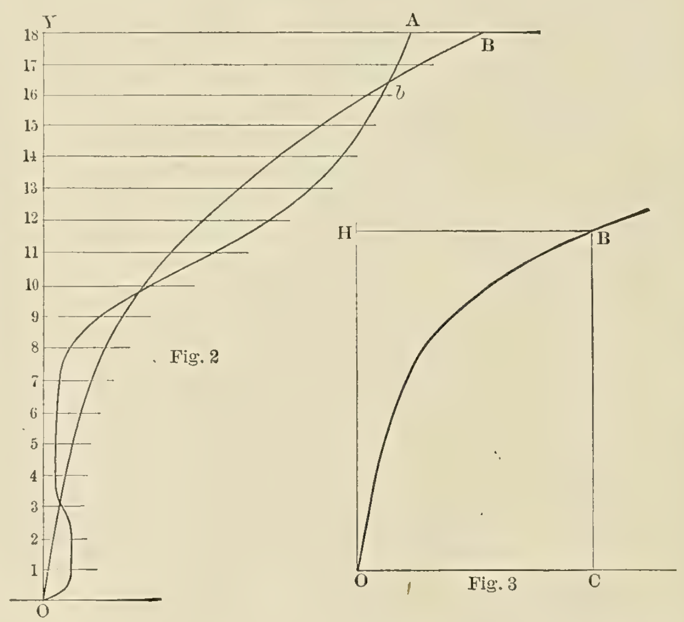


Fig. 2

Fig. 3

This factor is found as follows: Suppose the scale for laying off the ordinates for the curve OA representing water-line areas is 1 inch $= h$ square feet, and let the vertical scale be 1 inch $= k$ feet. Then 1 inch of area of OYA will represent hk cubic feet of the boat. To find the displacement we have therefore the following rules:

Let $a =$ any area on diagram, $OYA =$ corresponding ordinate of curve OB.

$h =$ scale for plotting OA.

$k =$ " " draft laid off on OY.

Then $hka =$ cubic feet of displacement of boat, and $hka \div 35 =$ displacement in tons of sea water.

Thus suppose OA plotted to a horizontal scale of 1 inch $=$ 100 square feet, while the scale for draft on OY is 1 inch $=$ 4 feet. Then let the area up to any given water-line as O 16 b measured by the planimeter be 2.3 square inches. The corresponding displacement volume will be $100 \times 4 \times 2.3 = 920$ cubic feet, and displacement $= 920 \div 35 = 26.3$ tons.

In this manner then the displacement to any water-line may be found, and the complete displacement curve plotted. The first item of the required information is thus complete. We next proceed with the centers of buoyancy.

In Fig. 3 let OB represent either the displacement curve or the curve OB of Fig. 2, plotted as above explained, and let OH be any draft at which the center of buoyancy is desired, and HB the horizontal representing the corresponding water-line. Then the distance of the center of buoyancy above the base OC will equal the average vertical height of the area OBC. To find this, simply measure the area OBC by planimeter, in square inches, and divide by the length of OC in inches. Then reduce the quotient to feet by the scale used on OH. Thus, for example, let the scale on OH be 1 inch = 4 feet, and let the draft be 10 feet. Then $OH = 2.5$ inches. Then let the area OBC measured by planimeter be 4.8 square inches, and OC be 3 inches. Then the average vertical ordinate of $OBC = 4.8 \div 3 = 1.6$ inches, and

(1) Redraw the body plan with complete sections, preferably, perhaps, the fore and after bodies separate to avoid confusion.

(2) Assume a water-line making the desired angle of inclination with the load water-line, and, as nearly as judgment may determine, cutting off a displacement slightly greater than that cut off by the load water-line.

(3) In Fig. 4 is shown for simplicity a single section with the load water-line WL and the inclined water-line W_1L_1. Then the whole problem of stability consists in finding the statical moments of a series of such sections about some fixed axis OP perpendicular to W_1L_1.

(4) Draw KO parallel to W_1L_1 and just tangent to the bottom of the section at K.

(5) Divide PO into any convenient or desired number of equal parts, say 9, and draw lines 1 b, 2 d, 3 f, etc.

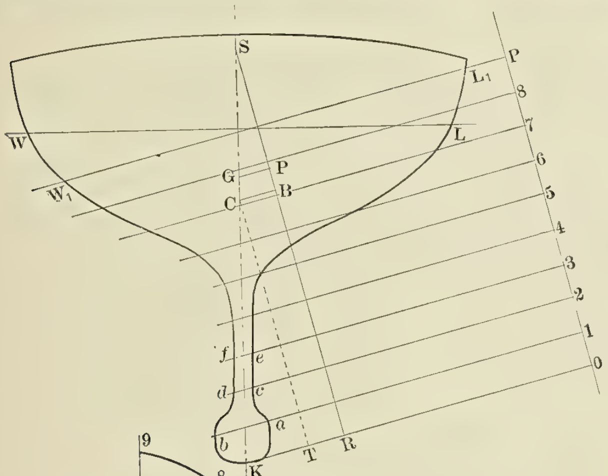


Fig. 4

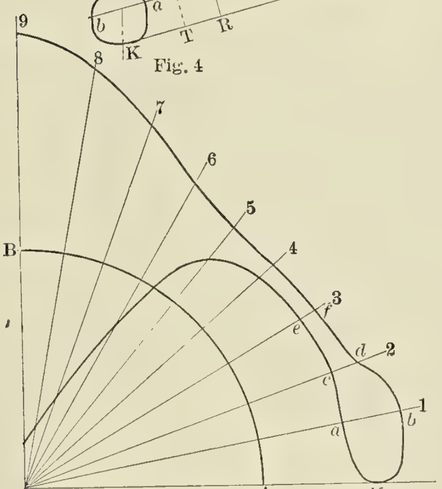


FIG. 5.

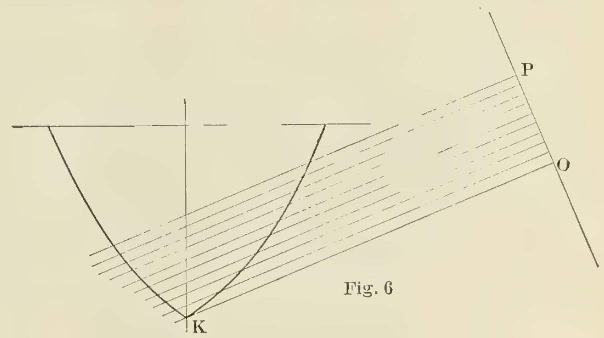


Fig. 6

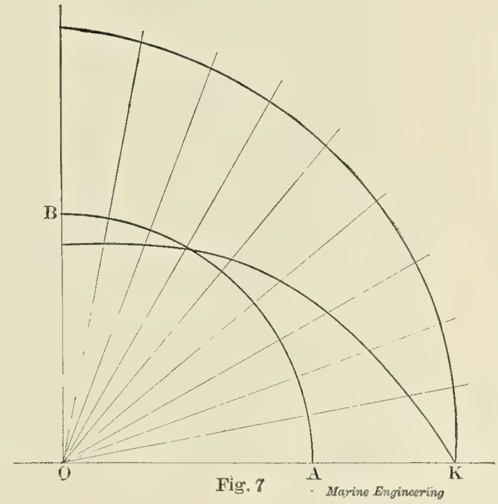


Fig. 7

this reduced to feet on the boat gives $4 \times 1.6 = 6.4$ feet. Hence for immersion to the 10-foot water-line the center of buoyancy will be 6.4 feet above OC, the bottom of the keel. In a similar manner the center of buoyancy for any other immersion may be found, and a curve of centers of buoyancy plotted in the usual manner if desired.

This short and simple manner of finding the center of buoyancy, having given the displacement curve, is not perhaps as generally known as its simplicity and rapidity in operation merit. In principle it is exact and not merely approximate. The mathematical proof would require more space than can be here allowed.

With regard to stability there are methods, almost legion in number, some with and some without instrumental aid. If an integrator giving both area and moment of section is at hand, the process becomes relatively short and simple. We shall not assume, however, the use of instrumental aid to this extent, but will first describe a method by the use of the planimeter. We assume further that the stability may be desired for any displacement close about the normal load value, either more or less. Then we may describe the operations in the following steps:

(6) Lay off a right angle and quadrant AB, Fig. 5, and divide into 10-degree intervals, drawing radial lines as shown. Then there will be 9 intervals corresponding to the 9 divisions of OP, Fig. 4. In any case, whatever the number may be, it should be the same for the distance OP, Fig. 4, and for the quadrant of Fig. 5.

(7) Transform the section KW_1L_1, Fig. 4, into that shown in Fig. 5 by laying off OK_1, Fig. 5, $= OK$, Fig. 4, and Oa, Ob, Oc, Od, etc., Fig. 5, respectively equal to 1 a, 1 b, 2 c, 2 d, etc., Fig. 4. The section of Fig. 4 will thus be transformed as shown into that of Fig. 5.

For the smaller sections near the ends, where the under-water body rises toward the surface and the depth of the section is but slight, as in Fig. 6, a smaller number of subdivisions will answer if desired, but in any case there will be an advantage in using the same angle of, say, 90 degrees in each case. In this case the transformed section is shown in Fig. 7.

(8) Take the area of the section of Fig. 5 by planimeter, noting the result in square inches.

(9) Multiply the area as found in (8) by the length OP, Fig. 4,

in inches, and the product will be proportional to the moment of the section of Fig. 4 about *OP*.

(10) Measure with the planimeter the area of the section of Fig. 4, also in square inches.

(11) Repeat the operations (4) to (10) for the series of sections throughout the length of the boat.

(12) Plot these values for moment and area on an axis of fore and aft length, the one giving a curve of sectional areas for the water-line W_1L_1, and the other a curve of statical moments of these sections about an axis *OP*. In running these curves out to zero at the ends aid may be obtained by noting on the body plan the approximate location between the sections at which the under-water body cut off by the inclined water-plane will run out to nothing. Such curves are shown in Figs. 8 and 9. In plotting these curves care must be exercised in the selection of scales to the end that the diagrams may result of size suited to the planimeter.

(13) Find by planimeter the areas of these curves, each in square inches, and divide the result for the moment curve by that for the area curve.

(14) Let the various scales be as follows:

For the sections such as Figs. 4 and 6, 1 inch $= n$ feet.

For the ordinates of the section area curve, Fig. 8, 1 inch $= p$ square inches.

For the ordinates of the section moment curve, Fig. 9, 1 inch $= q$ units as found in (9).

For the lengths of Figs. 8 and 9, 1 inch $= s$ feet.

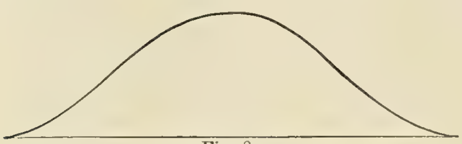


Fig. 8

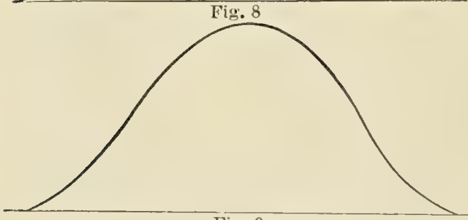


Fig. 9 *Marine Engineering*

Then multiply the quotient found in (13) by $2\,nq \div \pi p$, and the result will be the moment arm for the volume of displacement cut off by the inclined water-plane, and with reference to the axis *OP*.

(15) Lay off this arm to scale on the body plan as shown at *OR*, Fig. 4, and draw *RS* parallel to *OP*.

(16) Multiply the area of the curve of section areas as found in (14) by n^2ps and divide by 35. The result will be the displacement cut off by the water-line W_1L_1, in tons of sea water.

(17) For this displacement find from the previous computations the corresponding height of the center of buoyancy, and suppose it represented by *C*, Fig. 4. Then $CB =$ the surface stability arm, and if the center of gravity of the boat is located as at *G*, then $GP =$ the stability arm sought.

(18) The arm $CB = OK - OR - KC \sin \theta$, and all of these are known quantities found as above.

(19) Then $GP = CB - CG \sin \theta$, and this becomes known if the location of *G* is known.

(20) The product of *CB* or *GP* by the tons of displacement will give respectively the surface and actual stability in foot tons.

In a precisely similar manner the stability for any other angle or location of inclined water-line may be found. In order to make the investigation reasonably complete it will be necessary to carry through two series for the varying angles, one somewhat above the normal load displacement and the other somewhat below. In the details of the work many points may be seen where, by suitable dispositions, time and labor may be saved. The main outline only of the operations is given here.

(21) Having thus found the stability arms for two series of values of the angle of inclination, we may find the arm for any intermediate value of the displacement by simple interpolation between the values thus determined. Suppose, for example, that the normal load displacement is 80 tons, and that the stability arm at an angle of 30 degrees is desired. Let the two computations for 30 degrees result as follows:

Upper displacement 83 tons, stability arm 2.1 feet.

Lower displacement 78 tons, stability arm 2.2 feet.

Then $83 - 78 = 5$, and $80 - 78 = 2$. Hence the load displacement lies 2-5 the way between 78 and 83 and we take the arm correspondingly 2-5 the way between 2.2 and 2.1 or 2.16.

If in any case the displacement for a trial water-plane results too far from the mean load value, a second trial may be necessary.

The above series of operations will therefore serve to determine the stability for any proposed condition, and the third item is thus completely determined.

In a later issue some further discussion may be given regarding the determination of these same items by the use of ordinates.

W. F. D.

A SWISS LATEEN-RIGGED SAILING VESSEL.

A Form of Boat Used on Lake Geneva, Switzerland.

The illustration shows a peculiar type of sailing vessel used on Lake Geneva, for the purpose of carrying stone, sand, gravel, and wood, for building purposes at the French end of the lake. The rig consists of two lateen sails shaped very much like those in use on the Nile and certain parts of the southern shore of the Mediterranean Sea. The boats vary in length from 80 to 100 feet, and are about 25 feet wide. They are built of oak or elm, and the masts are made of either larch or fir.

REFRIGERATING PLANTS ON NEW UNITED FRUIT COMPANY STEAMERS.

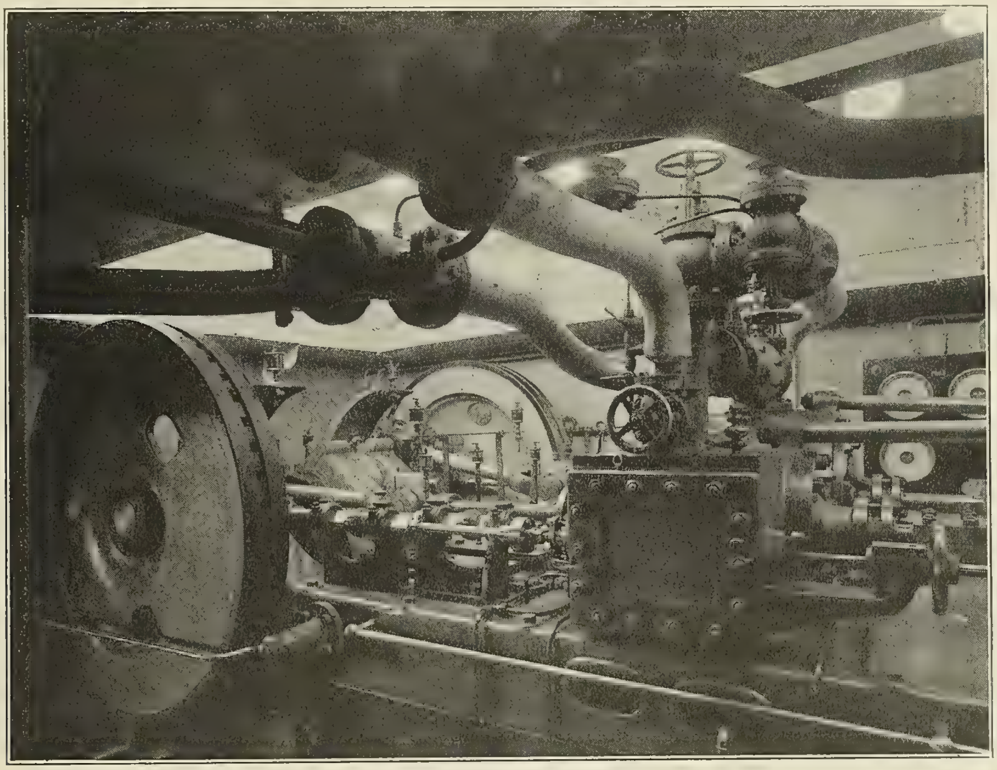
The three large steamers recently added to the United Fruit Company's fleet of steamships, and specially designed and fitted for the carriage of bananas, were built at Messrs. Workman, Clark & Company's shipyards, Belfast, Ireland, and were launched in order named: the *San Jose*,* the *Limon*, and the *Esparta*. These ships are practically built to the same model, although the last two ships are deeper in the decks. The dimensions are 343 feet by 44 feet 3 inches by 31 feet 3 inches. They have three steel decks extending the full length of the vessel, and the cargo spaces are divided into separate compartments by steel water-tight bulkheads extending to the upper deck. They have four insulated deck spaces forward, and three insulated deck spaces aft. All of the spaces are insulated with tongued and grooved boarding and cow-hair felt. The carrying capacity of each boat is from 45,000 to 50,000 bunches of bananas, and the net insulated space is about 140,000 cubic feet.

The main engines were constructed at Messrs. Workman, Clark & Company's engine works, and consist of a set of triple-expansion engines supplied with steam from three steel boilers working with the Howden's system of forced draft.

Each ship is fitted with refrigerating machinery installed by the American Linde Refrigeration Company, of New York, which company also fitted up the steamship *Venus*, another of the United Fruit Company's fleet. Upon this steamer a large number of experiments were made and valuable information collected, which was used to the fullest advantage in fitting up the three ships we are describing.

The refrigerating machinery is carried upon the upper deck in a separate compartment of the aft end of the steel deck-house. Immediately forward of it is a compartment containing the Linde air cooler, cooling the after end of the vessel. Another air cooler is contained in a compartment near the forward end of the same deck house, and controls the temperatures of the forward end of the vessel.

The refrigerating plant consists of one of the duplex marine type plants, having two double-acting ammonia compressors placed tandem to a compound steam engine, each compressor being driven by the prolongation of the steam piston rod, which is connected to the compressor piston rod by a removable and adjustable coupling. The machine is self-contained upon a massive cast-iron bed-plate, which is carried by a heavy steel tank bed-plate containing the ammonia condenser coils. The crank shaft is built up in two lengths, with a flange coupling between them, so that in the case of a breakdown of one of the two compressors the other can be run at full speed in order to fulfill the duty required. The steam connections to the compound steam cylinders are so designed that they may be run compound, or either may be run at high pressure, as required. The machine is designed for a working steam pressure of 160 pounds per square inch, and when at sea the exhaust is carried to the main engine condenser. There are two brine coolers, each connected to one compressor, but with the connections so arranged that either or both may be run to either or both of the compressors, or *vice versa*. These brine coolers consist of a heavy cylindrical wrought-iron tank provided with heavy water-tight cover so arranged as to admit of the evaporator coil being readily removed. Each tank contains a nest of six circular coils of extra heavy 1 1-4-inch piping, through which the ammonia is expanded for cooling the brine. The tanks are provided with automatic gas vents to pass off any gas that may be generated, and are also provided with suitable gauge glass fittings, which are taken through the insulation in order that the engineer can readily ascertain the quantity of brine the system contains. The coils pass through stuffing boxes contained in the tank, and the ends are connected with suitable headers for the distribution of the liquid and the collection of the gas. The amount of liquid passed through each coil can be regulated by a small valve.



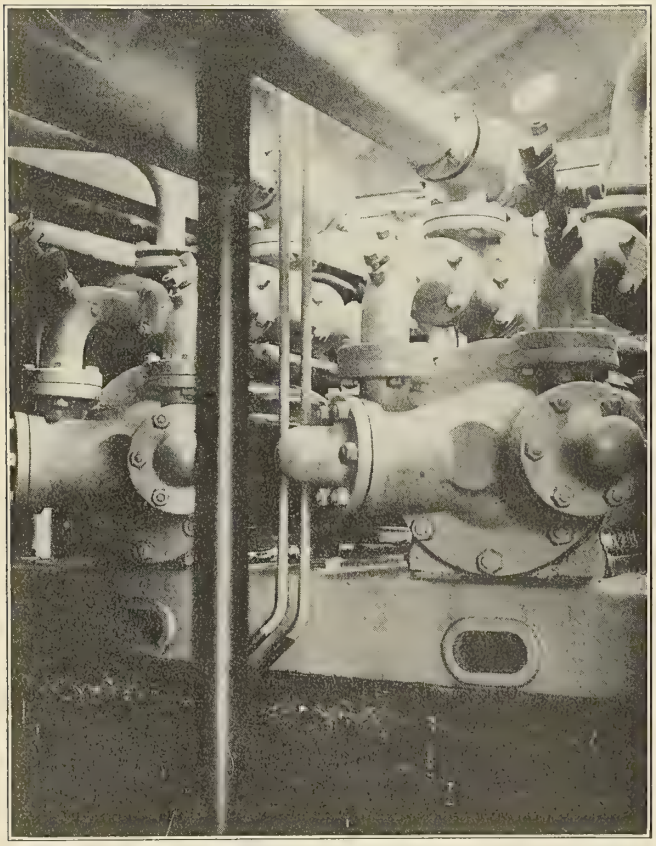
THE COMPRESSING ENGINES.

There are two brine circulating pumps of the centrifugal type, each coupled to a vertical high-pressure steam engine. The pumps are connected to the refrigerator tanks by cross-over connections that admit of either or both of the pumps working on either or both of the refrigerators. These pumps were specially designed for the duty, and were manufactured by the Kingsford Foundry &

* Described on page 487 of MARINE ENGINEERING for October, 1904.

Machine Company. The pumps are brass fitted throughout, and so constructed as to stand continuous day and night wear, and to perform the duty at a very low speed. These pumps are placed against the side of the deck house immediately behind the end of the compression cylinders, and are separted from the refrigerators by an insulated bulkhead which also insulates the after air cooler.

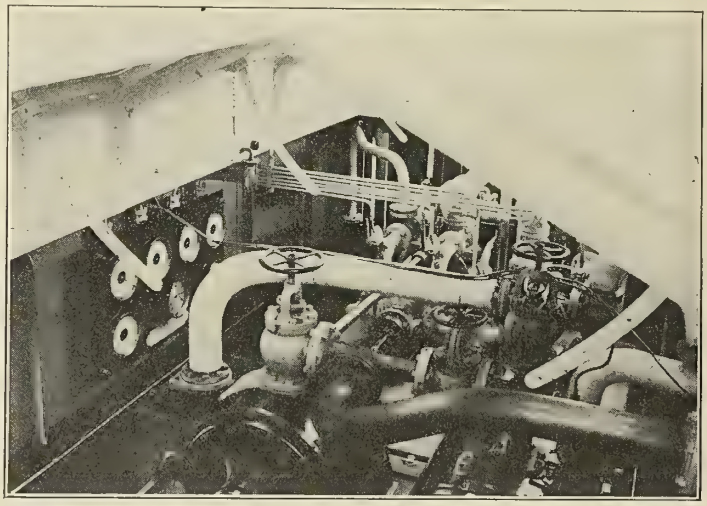
The water circulating pumps for the ammonia condenser are in duplicate, and are of the centrifugal type, direct-connected to a vertical steam engine, and are of similar design to the brine circulating pumps. These water circulating pumps are placed in the main engine room, and force the circulating water through the ammonia condenser tank, which has arrangements to insure a proper and even circulation. At one side of the refrigerating engine room are two direct steam-driven centrifugal brine spray pumps. These pumps circulate the cold brine, and send this solution in the form of spray over the coils in the air coolers, so as to increase their efficiency and clear the air from any impurities which it may contain.



AMMONIA CYLINDERS.

The two air coolers have been carefully designed to meet the special requirements of the United Fruit Company, who have had unique experience in the carrying of perishable fruit cargoes in general, and of bananas in particular. Provision has been made so that not only can the volume and the temperature of the air discharged be adjusted, but as far as possible, the humidity can be modified from what would be the normal saturation point corresponding to its temperature. A point of vital importance is the maintenance of large volumes of air in as dry a state as possible for certain periods, and this has been most carefully provided for. Each cooler is provided with a large fan, specially built for the work, which is direct-driven by a vertical steam engine, and is designed for continuous day and night running. These fans were constructed by the Sirocco Engineering Company. They are of the heavy steel plate, cased construction with double intakes, and will furnish the necessary volume against a water pressure of 3 or 4 inches. This duty is performed when running at a speed of about 350 revolutions per minute.

The air circulation and the arrangement of the air trunks for the delivery of the cold air into the insulated chambers and the suction ducts back to the coolers, have been very carefully considered and studied. The question of uniform and sufficient distribution of suitably cooled air necessary for the proper preservation of this most delicate fruit, has always been one of great difficulty, and special care has been given to this part of the work in order to eliminate, as far as possible, the bad results attendant upon imperfect air circulation. In this matter the engineers have been guided to a large extent by the information obtained from actual experiments conducted on the steamship *Venus,* which, as before mentioned, was fitted up with a plant upon similar lines, and has been running in the same trade for over a year. The air trunks and ducts have been designed to give the maximum amount of efficiency with the minimum amount of space, or, in other words, the fruit carrying capacity has been reduced as little as possible. The decks of the insulated chambers are provided, as usual, with gratings. The suction air trunks are arranged overhead in such a manner that no storage space is lost. For the cold air delivery ducts the spaces between the reverse frames have been utilized in an ingenious manner, and these chutes or ducts are so subdivided that the proper proportionate amount of cold air is introduced into the fruit spaces in certain points or stages, so that an even distribution, which is of the utmost importance, is obtained.



THE DUPLEX PUMPS ON ESPARTA.

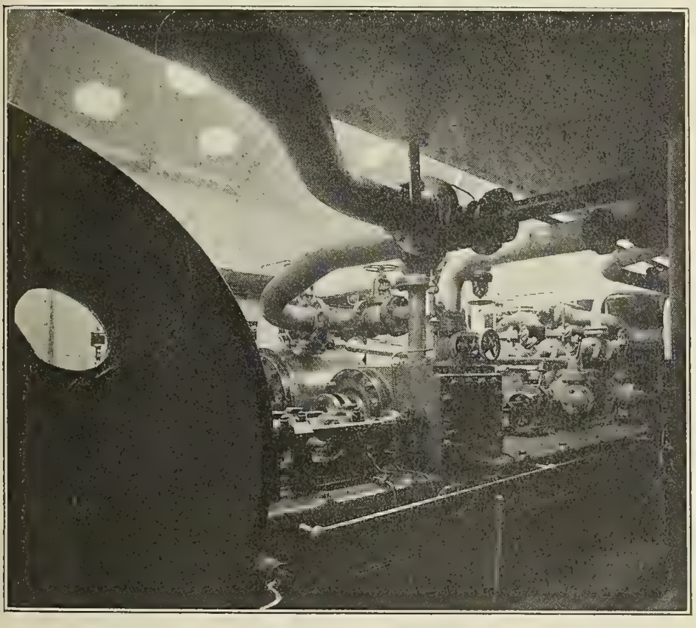
The air chutes are provided with small slides, so as to regulate the amount of air withdrawn from the chambers. There are also traps for cutting off the main chutes to each of the separate chambers, and a simple arrangement is embodied in the air chutes by means of which the air currents can be crossed over; in other words the air can be introduced into the top or bottom of the chamber at will. There are also connections by means of which fresh air from the atmosphere is circulated over the coolers and into the fruit chambers, and also the air in the cold chambers discharged overboard.

We may mention that these plants are provided with an appliance by which the insulated spaces may be raised in temperature as required, by the circulation of air gradually heated by the brine circulation being warmed up by a steam heater. This has been found necessary to guard against the chilling effect of the winter season in the home ports. By this means the temperature of the fruit at the port of discharge can be regulated at will to suit the requirements of the port and market.

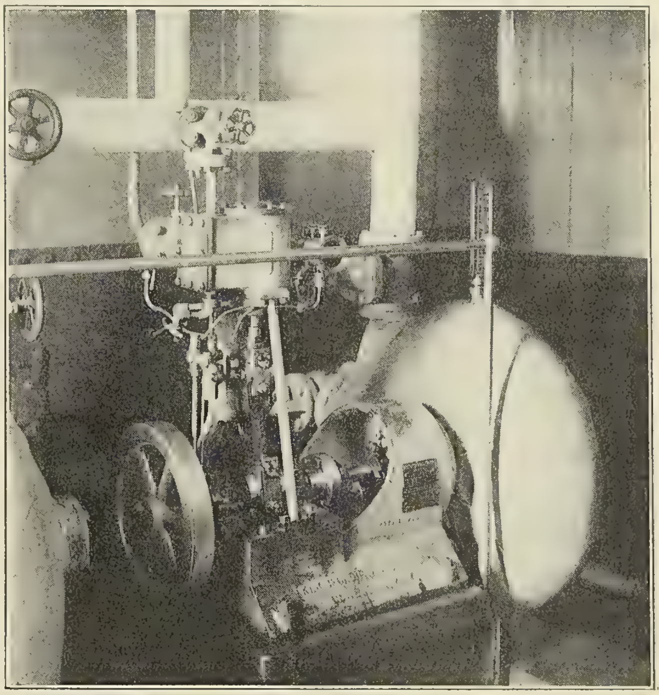
The temperatures are read by thermometers hanging within thermometer tubes, all passing to the upper deck, and fitted with screwed brass caps. That the air circulation and temperatures are uniform is proved by the thermometer readings, it being found that the variation throughout the whole of the insulated space does not vary more than about 1 1-2 degree Fahrenheit. These thermometers are of a specially sensitive type, supplied by the Hohman & Maurer Manufacturing Company, who also constructed the special transmission thermometers by which the reading of the various air temperatures are taken upon the outside of the insulated compartments.

The actual cooling is effected by the vaporization of liquid ammonia generated in the condenser coils by the combination of the pressure obtained by compression and the cooling effect exerted by the condensing water. The liquid is vaporized in the coils of the brine coolers, thus reducing the temperature of the brine, and the ammonia vapors are then drawn by the compressor and forced into the condenser, thus completing the cycle of operation.

The air coolers consist of vertical sheets of iron piping with the necessary headers and regulating valves, through which the cold brine is continually circulated by the centrifugal pumps before described. The warm air from the cold chambers is drawn out by the fans, forced over the outside surfaces of these cold brine pipes,



THE COMPRESSORS.



BRINE-CIRCULATING PUMP.

and is discharged into the cold chambers in a continuous circulation. The two small spray pumps before referred to pass a certain quantity of cold brine solution over the outside of the coils in the form of a spray. This spraying arrangement is divided into sections in a special manner, so that any number of sprays may be used as found necessary, and quantity of cold brine spray delivered can be regulated, or completely shut down.

This circulation of the cold brine over the exterior surface of the air cooler coils has several advantages. The air drawn from the cold chambers in which are stored large quantities of freshly loaded fruit is naturally at the earlier stages in a more or less impure condition, and contains a large amount of foreign matter in suspension, which is separated by the cold brine sprays and caught and collected in the tank containing the air cooler coils. The air is also sweetened and purified, and, in addition, the coil surface is rendered more active, and greater efficiency obtained. On a long voyage the air in the cold chamber is gradually cleared of the carbonic acid given off by the fruit, and otherwise purified by the process of cooling, and the duty required of the spray pumps is gradually decreased, so that after a number of days of continuous work the spray pumps can be shut down.

The air cooler tank is provided also with an arrangement of baffle plates by means of which the spray is prevented from being carried over by the air, and the moisture which is taken from the fruit is automatically collected and discharged overboard. A number of trays are also provided for the reception of chloride of calcium in a dry state, should extra dryness of the cold air be required.

It will readily be understood that the carriage of delicate, perishable fruit is a matter requiring a large amount of skill and attention, and the satisfactory carriage of refrigerated bananas upon a long voyage, a considerable portion of which is under tropical conditions, requires great care. Many things have to be considered, such as the grade and age of the fruit, length of voyage, atmospheric conditions under which the fruit was loaded, climatic conditions affecting the plantation from which the fruit was obtained, atmospheric conditions during the voyage, method of storage, and the requirements of the market at the discharge port. All of these conditions affect the determination of the volume, state of humidity, temperature of air to be circulated, and the temperatures to be maintained within the cold storage spaces, and likewise the amount of fresh air to be drawn from the atmosphere and circulated over the fruit.

These ships were intended for the banana trade between Port Limon and Boston, but have recently been running from Port Limon to New Orleans. The bananas are loaded in the ship at Port Limon by two endless conveyors, one working upon the forward end and one upon the after end of the ship. These conveyors receive the fruit on the wharf and deliver it on the upper deck immediately over the hatchways. Each machine is driven by a steam engine and the fruit is conveyed upon a wide, endless belt, the top or delivery side of which is forced into a V or trough section by means of jockey pulleys arranged at a proper angle. The delivery end of the machine is made fast to the ship, but the feeding end, which carries the driving gear and steam engine, is mounted upon a strong foundation plate fitted with rollers, so that the movement of the machine caused by the riding of the ship can be taken up. The machine is supplied with steam through a flexible hose from the winch pipe on the ship's deck.

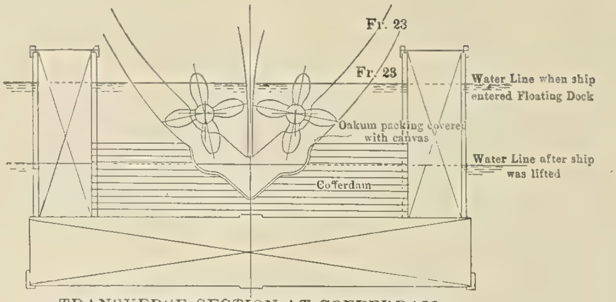
The fruit is unloaded at New Orleans by a machine invented, we believe, by Mr. G. J. Edelston, one of the engineers of the United Fruit Company, and erected by the Harris & Edelston Conveyor Company. This machine is capable of meeting the requirements of any size of ship, and has been very successful. It has a vertical section swinging upon an auxiliary boom, which may be regulated to suit the beam of the ship. This vertical section is lowered into the ship's hatchway, and is fed from all the deck spaces simultaneously. The bunches of bananas are then lifted by an endless belt in a vertical direction over the top of the machine, and conveyed downward into the railway sheds, and are finally delivered by a horizontal length upon a table close to the refrigerator railway cars. This is an endless belt arrangement over a number of horizontal roller bars, the belting being slack, and so naturally forming a kind of a hammock or bag, and owing to this particular construction the fruit sustains no violent shock at any point of its transit. The machine is driven by two electric motors, and is self-contained and mounted upon a strong bed plate. It has a transverse travel along the rails upon the wharf, so as to be brought into proper position with respect to the ship. Two of these machines are said to be capable of unloading 50,000 bunches of bananas in about eight hours.

These three ships have been thoroughly tried out and tested under all conditions. They have been made to consume twelve days on a nominal five- or six-day trip, and have anchored in tropical seas with fresh cargoes aboard, in order to put the refrigerating machinery to the severest test possible. The *San Jose* has been in commission since August 3, 1904, the *Limon* since September 21, 1904, and the *Esparta* since October 26, 1904. The plants have given excellent results, and represent the most recent practice of this particular branch of refrigeration.

Repairs to the Steamship Shawmut.

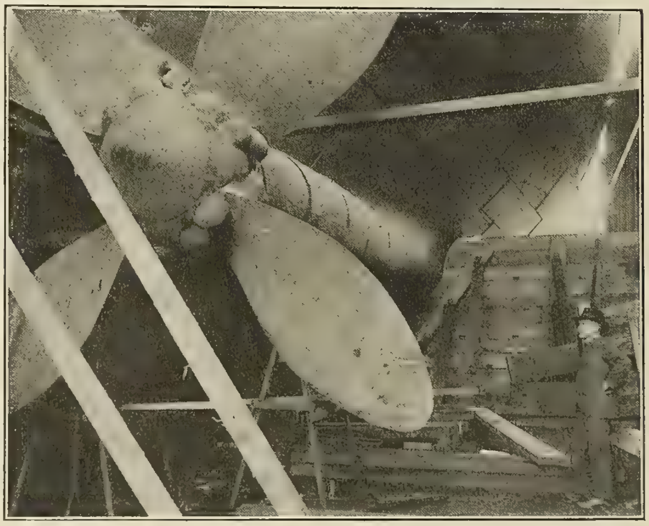
Due to the fact that the United States government imposed excessive docking rates for the use of the dry-dock at Bremerton, in the Puget Sound navy yard, the Moran Brothers' Company, of Seattle, Wash., were driven to a very ingenious and decidedly novel expedient in making repairs to the steamship *Shawmut** of the Boston Steamship Company. The *Shawmut* is a ship about 500 feet long and of 9,606 tons, and the figure first quoted by the government for the use of the dock for the estimated required time of twenty-one days, was $21,133.20. Upon application through Hon. W. E. Humphrey, congressman from Washington, this figure was ultimately reduced to $15,527.20, against which the British dock at Esquimalt, British Columbia, offered a charge of $5,042.40.

The Moran Brothers had determined, however, not to allow the repairs to go to a Canadian firm, and they therefore prepared



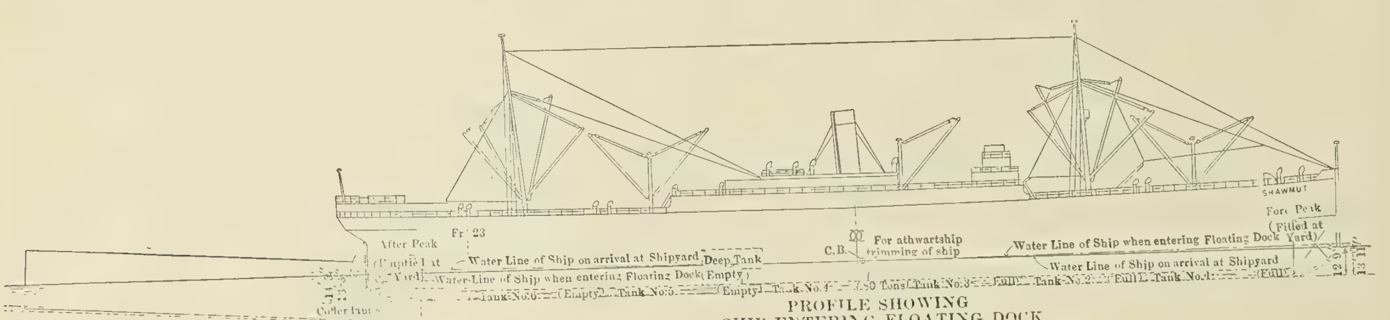
TRANSVERSE SECTION AT COFFERDAM SHOWING STERN OF SHIP ENTERING FLOATING DOCK *Marine Engineering*

to make use of their own floating dry-dock, which has a length of only 200 feet and a maximum lifting capacity of 2,700 tons. The *Shawmut* went aground in Chinese waters, and sustained a double fracture in her stern frame, but managed to reach Puget Sound before the repairs were made. The fact of the accident, however, was reported by cable to the home office, and a new stern frame steel casting was ordered from the shops of the builders, the Maryland Steel Company, of Sparrow's Point, Baltimore, and this was shipped to Seattle in time to be worked into the vessel on her arrival there. The illustrations which we give show that when the stern of the vessel was placed in the dock the

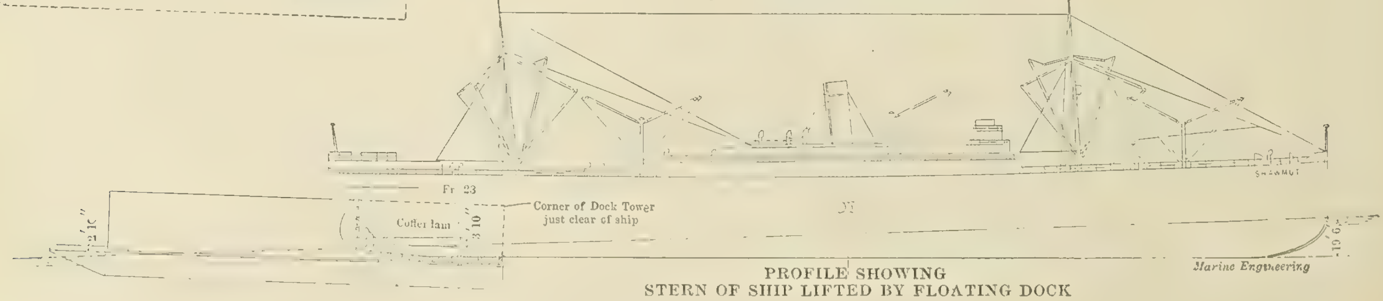


VIEW OF THE COFFERDAM AND STARBOARD PROPELLER.

*Described and illustrated on page 1, Marine Engineering, January, 1902.



PROFILE SHOWING SHIP ENTERING FLOATING DOCK

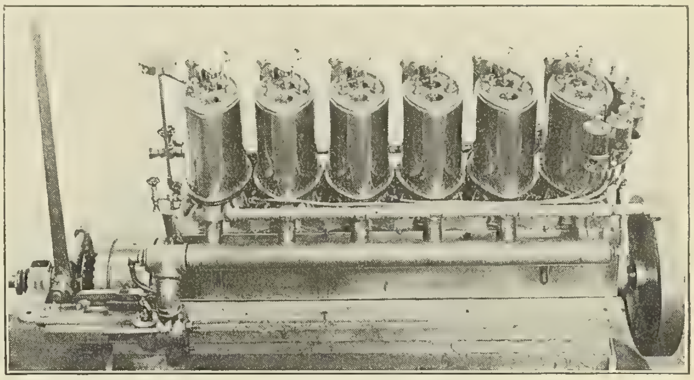


PROFILE SHOWING STERN OF SHIP LIFTED BY FLOATING DOCK clearance between the side of the ship at frame 23 and the corners of the wings of the dock was only a fraction of an inch, while the dock itself, having insufficient lifting capacity to raise the stern entirely out of water for the purpose of making the repairs, was fitted with a cofferdam, modeled to the form of the stern of the ship and calked in order to make it water-tight, after the ship was placed in position. This having been done the water in the dock back of the cofferdam was pumped out, and the stern of the ship thus laid dry for the purpose intended. Our two photographs show the general character of the work done, as well as illustrate the cofferdam used as above.

GENERAL VIEW OF THE REPAIR JOB ON THE SHAWMUT.

A New 26-Mile Auto-Boat.

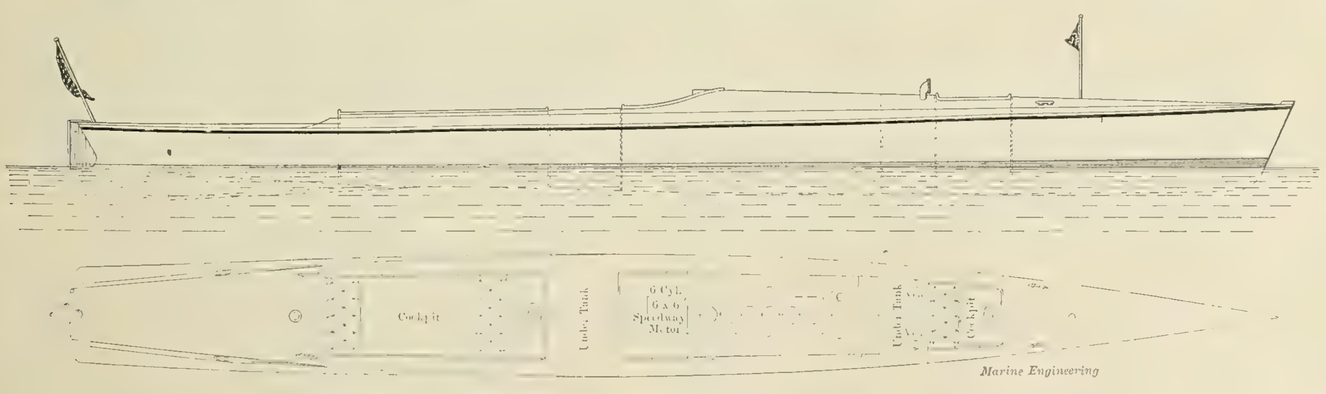
The accompanying design shows the general arrangement of a new 45-foot speed launch now building at the Morris Heights works of the Gas Engine & Power Company and Charles L. Seabury & Company, Consolidated, to the order of E. J. Schroeder, of Jersey City. This new motor boat is 45 feet long and of attractive model. The planking is double, of white cedar, with frames of oak, and inside double girders to give stiffness to the hull and to carry the motor. A hooded or "turtle-back" deck will cover the forward portion of the craft, giving protection to the machinery. The passenger cockpit only will be open. The steersman's cockpit forward of the motor will be used when the weather permits, and at other times will be covered with a hood. The finish of the decks and cockpits will be of Spanish cedar, polished and varnished. The motive power will be a six-cylinder,



60 horsepower "Speedway" engine of the latest auto-marine type, and the speed expected by the builders is 26 miles per hour. The boat will be delivered on or about the 15th of May, and will be entered in the motor-boat races of the coming season. During the season of 1904, the owner had in service the 40-foot "Speedway" auto-boat *Japansky,* the winner of the Manhasset Bay Yacht Club race for boats of her class on Memorial Day of that year.

The Oyster Boat Stranger.

There was recently launched from the shipyard of J. S. Ellis & Son, Tottenville, N. Y., the oyster boat *Stranger,* for the owners, Ockers & Company, New Haven, Conn. This is one of the largest and best-equipped oyster boats in the business. The boat is 72 feet over all, 21 feet 6 inches beam, 5 feet 6 inches depth, 5 feet draft, 40 tons gross, 35 tons net, and has a capacity of 2,500 bushels of oysters. She makes an average speed of 10 miles an hour, and is fitted as a dredging boat. She is equipped with "automatic" gasoline engines of 60 H. P., manufactured by the Automatic Machine Company of Bridgeport, Conn. There are three independent cylinders, operating four-cycle, each having its own independent valve motion, so that each cylinder is a complete engine in itself. This makes it very convenient to get at for adjustment and repairs. In case of necessity one cylinder can be cut out and the engine run on the other two. The crank shaft is a massive steel forging in one solid piece. The reversing gears are of forged steel bushed with bronze and run on hardened steel pins. One great advantage of an engine of this design is that the pistons can be removed without disturbing any of the piping, valves, or igniters, the cylinder heads being light and readily removed. The reversing clutch is secured to the engine by a flange coupling at the after main bearing; by removing

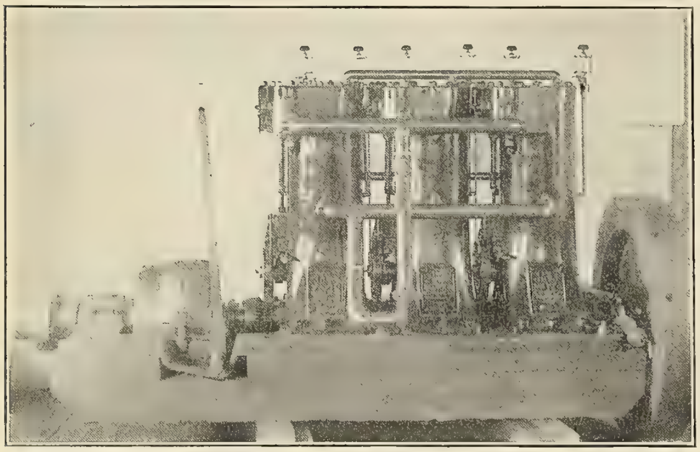


NEW SPEED LAUNCH FOR MR. E. J. SCHROEDER.

THE OYSTER BOAT STRANGER.

bolts from this coupling and the propeller coupling the gear can be lifted out intact. The thrust is taken up in the after bearing by a steel shaft with numerous collars turned from the solid metal and run in a high-grade babbitt bearing. The bearings are all babbitted up to a master shaft and scraped, so that all bearings come into perfect line.

The igniters are a simple and durable design and can be removed intact; there is a ground joint between cylinder and igniter castings. The electrode arms are clamped in position



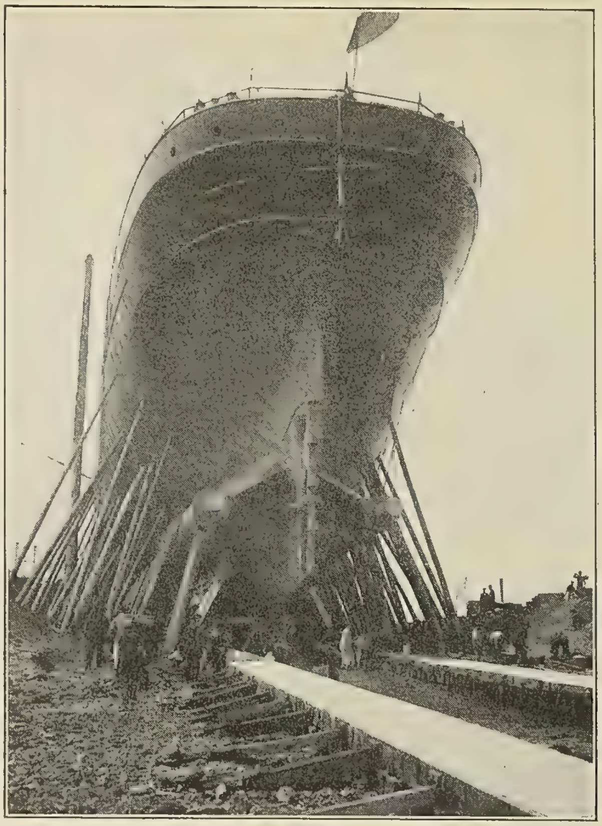
ENGINE OF THE STRANGER.

and allow for easily adjusting for wear and repairs. There is a special "Automatic" vaporizer and independent adjustment for the air and gasoline, which gives a range from 75 to 300 R. P. M., all controlled by one throttle valve.

The dredging outfit consists of one of the largest size "Automatic" fore-and-aft double-arm hoisters, and is equipped with "Automatic" dredges of 15 bushels capacity. There is an extra wide brake band for braking, extending nearly the whole diameter of drum and operated with rack and pinion, which gives a very simple and durable gear.

The Launch of the New French Liner La Provence.

On the 21st of March the latest flyer of the French Line was successfully launched near St. Nazaire, in the presence of the Ministers of Commerce and Public Works and the First Secretary of Marine. The *Provence* is of considerably larger size than the ships of the French Line at present in service, and, indeed, is the largest ship of the French mercantile marine, and the largest ship ever built in France.



LA PROVENCE ON THE WAYS.

She has a length of 625 feet with beam of 69 feet, and displaces at a draft of 26 feet 19,200 tons. She is fitted with two engines operating twin screws and developing a total of 30,000 indicated horsepower, with which it is expected that a speed of 23 knots will be maintained. The draft has been limited because of the fact that the harbor of Havre, which is the eastern terminus of the trip of the French liners, is relatively shallow, and will not admit of the draft given the English ships entering the port of

LA PROVENCE AFLOAT.

New York. The ship was commenced in December, 1903, and is expected to be ready for service early in 1906. It was proposed when the plans were being considered to fit her with turbine engines, but the Companie Generale Transatlantique had scarcely the courage to initiate this system in a steamer of such importance. Her crew numbers 439 all told, and she has provision for 1,900 passengers.

J. Peltier.

The Stern Post and Heel-Piece of Warships.

BY EDWIN CERIO, NAVAL ARCHITECT.

The accident which recently put an end to the trials of the German battleship *Elsass*, may be described as a fracture of the rudder bearing-piece *(heel-piece)*, due to the vibrations of the stern at the high speed at which the vessel was running, and a consequent loss of the rudder. The accident alluded to, and its repetition under exactly the same circumstances in a number of ships fitted as the German man-of-war above mentioned, will not fail to call the attention of naval authorities to the structure usually adopted in warships having three screws and a balanced rudder. This structure consists of an extremely complicated stern post of cast steel, one part of which forms, so to speak, an arm protruding outside of the ship and serving to support the rudder. This arm is the *heel-piece*, and it carries the gudgeons for the rudder pintles. Heel-piece and stern post are cast in one piece, so that the latter is made to share the fate of its most fragile appendix, the fracture of which makes it indispensable to demolish the whole stern, tear away the outside plating, remove the stern post, frames, etc., and undertake a costly and lengthy reconstruction after the damaged stern post is replaced by a new one.

According to *Schiffbau*, the repairs necessary to put *Elsass* in order again will require a period of from one to three months; and though this estimate may have been made in a very optimistic frame of mind, it shows how serious the consequences of an accident to the heel-piece of a modern battleship may be. In time of peace the apprehension caused by this defective structure may be a cause of dissatisfaction in regard to a ship, but in time of war it may become an element of unreliability which it is most important to remove. Take for instance the case of a 16,000-ton battleship, completely armed and equipped, ready for action; a quite plausible assumption is that an external cause, such as grounding, the hit of a torpedo, etc., will produce the fatal fracture in the heel-piece, and the battleship which, *without* that insignificant fracture, would be capable of using all the destructive energy stowed in her sides, is condemned for months to idleness.

As the three-screw system and balanced rudders are becoming every day more popular, naval constructors must give a thought to the system of stern post adopted in ships thus fitted and answer the question: Is it possible to so modify the existing structure that an accident damaging the heel-piece will not disable the whole ship for a long period?

I have tried a practical solution of this problem which I here briefly describe and illustrate with the accompanying drawing. In my opinion much weight ought to be laid on the following points:

(1) Stern post and heel-piece must be independent from one another, and their structure ought to represent the best compromise between simplicity and solidity. Strength obtained at the cost of complicated castings, and lightness secured by reducing the thickness to the theorical *minimum* determined by calculation, are apt to prove uneconomical, and, what is worse, fatal to the ship's military value.

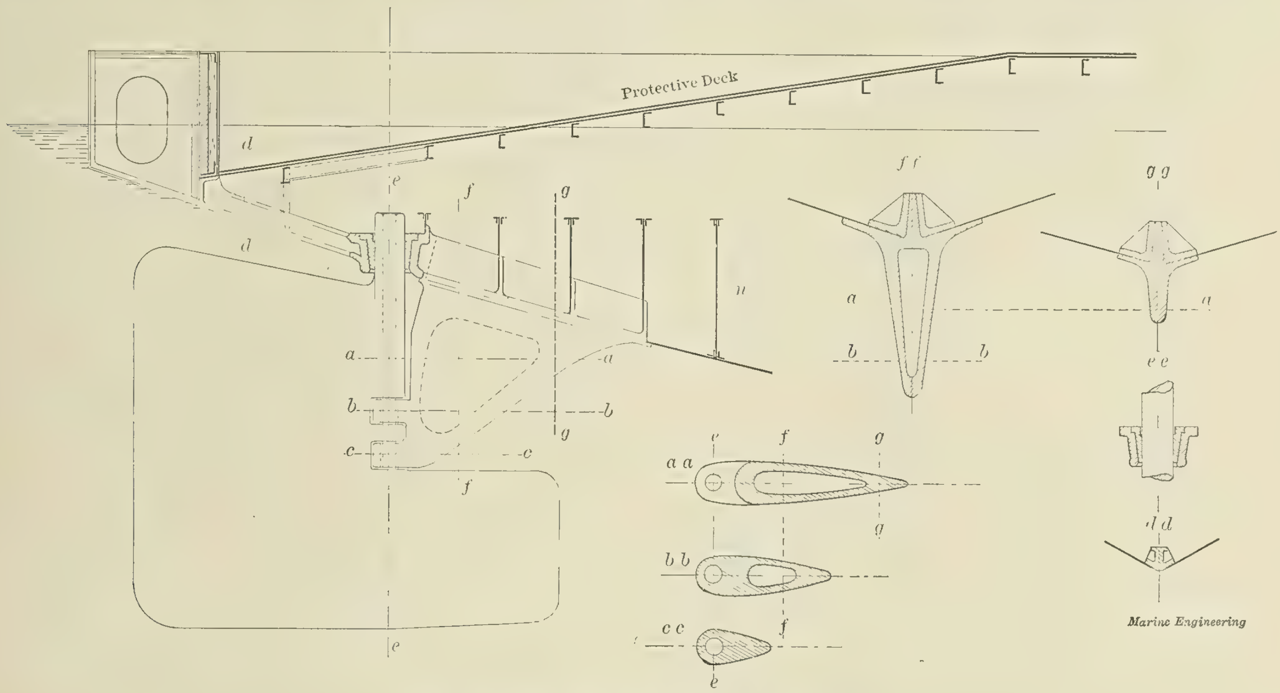
(2) Stern post and heel-piece must, therefore, be made of two separate castings, solidly connected together by means of rivets and bolts.

(3) The operation by means of which the part eventually damaged (as a rule the heelpiece) is removed and a reserve piece, *kept ready on board*, is replaced, must be capable of being simply and quickly performed.

(4) The structure must be such that in case of accident the necessary repairs will concern only the damaged part, and not involve the demolition and reconstruction of the whole stern of the vessel below the water-line. Experience has taught that this reconstruction, owing to the locality where the work must be done (under the armor deck) is a fastidious and costly job.

As the fracture, when the heel-piece is struck, usually takes place along the line *a-a* (see figure), or may, by means of an adequate construction, be made to take place in this direction, the proposed system has been designed with a view to embodying the suggestions above mentioned.

The drawing shows clearly all particulars of the modification I suggest to the system now in use; the horizontal sections *a-a*, *b-b*, *c-c*, and the vertical sections *d-d*, *e-e*, *f-f*, *g-g*, furnish exhaustive details of this structure, which aims to combine constructive with economical advantages.



DESIGN FOR STERN POST AND HEEL-PIECE IN WARSHIPS.

Mr. Grant B. Shipley has severed his connection with the Union Iron Works, of San Francisco, where he was chief draftsman of the mining department, and is now to be found with the Allis-Chalmers Company, in Chicago.

THE RECONSTRUCTION OF THE TURKISH FLEET.

BY DAGNINO ATTILIO.

The reconstruction of the Turkish fleet has for so many years been regarded as more or less of a myth that it is not generally known that anything definite has been accomplished. It is a fact, however, that although the complete reconstruction may never take place, a very substantial beginning has been made by the rebuilding, by Messrs. Ansaldo, shipbuilders of Genoa, of the largest ship in the Turkish navy, the *Mess'oudijeh,* and by the construction of four 26-knot torpedo-boats, and the further construction of seven of the same type, which are now rapidly nearing completion in their yard.

The *Mess'oudijeh,* which was designed by Sir Edwin J. Reed, late chief constructor of the British navy, and was launched on the Thames as long ago as 1874, has been transformed from a superannuated and, from a military point of view, almost valueless ironclad, into a very formidable ship. She has a displacement of 9,200 tons, measures 331 feet over all, 315 feet between perpendiculars, has a beam of 59 feet, with a maximum draft between 26 and 27 feet. The old armament was twelve 18-ton, 9-inch muzzle loaders, located in a central box battery; two 6-ton, 7-inch muzzle loaders, located forward; and a similar pair aft, and a few small guns. The battery was protected by 12 inches of wrought-iron armor, the armor belt varying in thickness from

THE MESS'OUDIJEH BEFORE RECONSTRUCTION.

8 to 12 inches. With a total indicated horsepower of 7,430, the ship reached a speed on trial of about 13 knots. She was a full-rigged ship and was one of the latest single-screw warships built in England. At that time she was a formidable craft, comparing very favorably with ships of all the principal naval powers of that date.

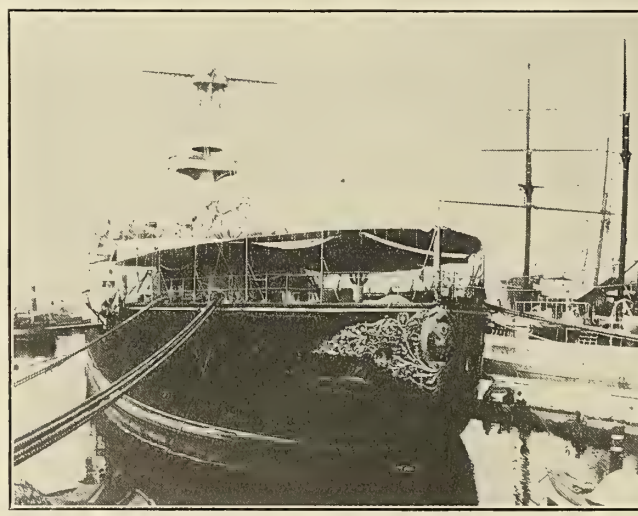
Twenty years after her launch her military value had so decreased, owing in part to the Turkish method of allowing ships to go to rust, and in part to the coincident progress in the design and construction of warships, as to have almost disappeared. About that time the Sultan Abdul Hamid II displayed a personal interest in naval matters, and negotiations were at once instituted with Messrs. Ansaldo looking to the reconstruction of this ship. Upon examination the hull was found to be in splendid condition, but otherwise she was practically hopeless. The engines were so badly rusted as to have fallen apart in many places, while the boilers bore a distinct resemblance to sieves. With considerable difficulty the ship was navigated to Genoa, and after many delays, due to the habitual procrastinating policy of the Turkish government, the rebuilding was taken in hand.

The first, and in many ways most difficult part of the task, was that necessitated at the stern, due to the fact that the substitution of twin screws for the old single screw was one of the features of the reconstruction. The ship was not lengthened, but a complete new stern was fitted to accommodate the new condition of affairs. Practically all of the old bulwarks fore and aft, including both the old poop and forecastle, were removed *in toto,* and amidships a light iron superstructure was built.

For the twelve old 18-ton guns in the central-box battery amidships have been substituted an equal number of 6-inch Vickers rapid-firing guns, 45 calibers long, and so situated that two can fire almost directly forward and two almost direct astern, while all, of course, have a considerable arc of fire on the broadside. These guns use the old gun ports, slightly enlarged, and are protected behind 4-inch shields. Forward and aft, on the main-deck, have been constructed barbettes, built on the "shallow tray" system, and carrying 6-inch turret shields over them. In each of these positions is located a Vickers 9.2-inch gun. The secondary battery consists of ten 3-inch, 14-pounder, rapid-firing guns, placed in the upper-deck superstructure, with two more of the same size forward under the main-deck, and two aft. On the flying-deck, over the superstructure, are ten 6-pounder guns, while the new military mast, placed aft of the two funnels, carries two 3-pounders.

An entire new set of engines has been built, being four-cylinder, triple-expansion engines, with cylinders as follows:

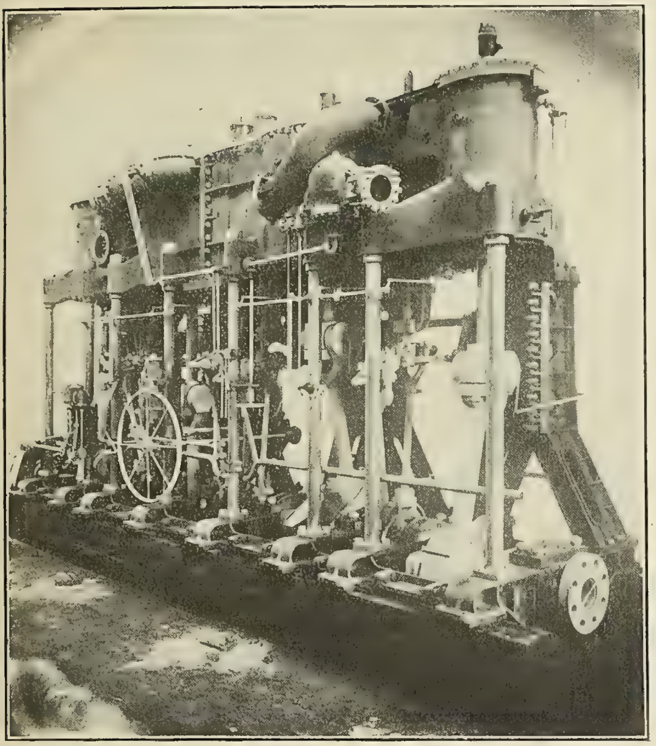
The propelling engines are right- and left-handed, and turn inwards. They are placed, as usual, side by side in separate



STERN OF THE RECONSTRUCTED IRONCLAD.

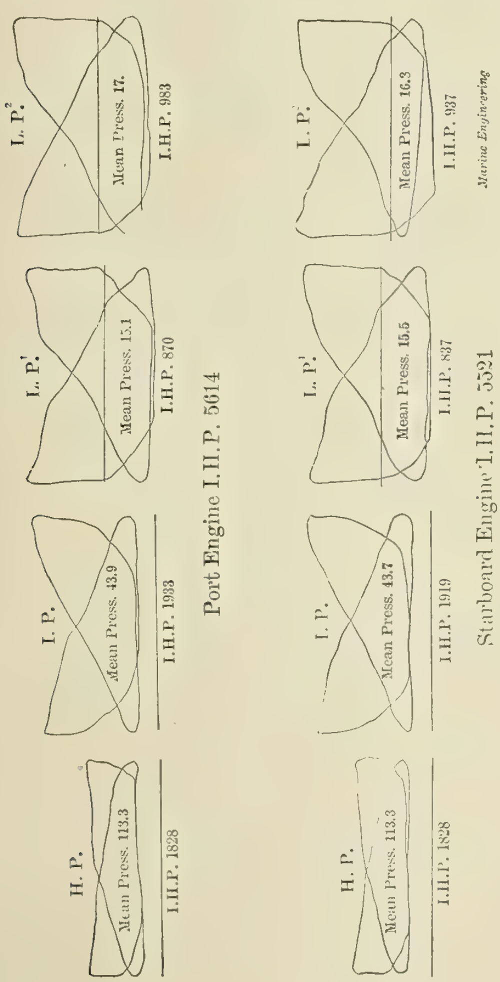
water-tight compartments, and are balanced on the Yarrow-Schlick-Tweedy system, the two low-pressures being between the high- and intermediate-pressures. The balancing has been proven to be most effective. The valves for the high- and intermediate-pressure cylinders are of the piston type, while the low-pressure cylinders use double-ported slide valves. The cylinders are independent castings, the two low-pressure cylinders forming a solid body with the low-pressure receivers, while the high- and intermediate-cylinders are secured to them by means of flanges and bolts. The engine framing consists of a cast-steel housing at the back and forged-steel columns at the front. The pistons are of cast steel, conical in shape, and all cylinders are fitted with working liners and are jacketed. The bed-plates are of cast steel.

There is a steam separator and a reducing valve for each engine, fitted on the forward engine-room bulkhead. The reversing gear is of the "all round" type, fitted with a double-cylinder engine. The two main condensers are separate and are placed in the wings. They are cylindrical, with shells of sheet brass and doors and tube plates of gun-metal. The total cooling surface is 11,030 square feet, which figures out at almost exactly one square foot per indicated horsepower of the engines. The water is supplied by two circulating pumps with runners 43 1-4 inches in diameter, each pump being operated by a double-cylinder engine measuring 8 1-4 by 8 1-4 inches. The exhaust



THE NEW ENGINES OF THE MESS'OUDIJEH.

steam from all auxiliary machinery on board is so connected that it may be led either into the funnel or into an auxiliary condenser in the port engine room. This latter condenser has its own air and circulating pump, entirely independent from the



MARINE ENGINEERING DATA CARD. **MAY, 1905.**

NAME—Mess'Oudijeh. NATIONALITY—Turkish. OWNER—Turke .

LAUNCHED—1874. RECONSTRUCTED—By Messrs. Ansald

Length over all.............................331 ft.
" between perpendiculars.............315 "
Beam molded ....59 "
Maximum draught..............................27 "
Normal displacement.....................9,200 tons
Engines.........twin screw, four-cylinder, triple
Cylinder diam..30, 49 1-4, 56 5-16, and 56 5-16 ins.
Stroke ....43 5 16 "
Piston rods, diam...............................7 "
Connecting rods,
mean diam. 7 11 16 ins., bored 4 ins.
" rods, length,
center to center, 7 ft. 2 5-8 "
Shafting, diam..............................all 15 5-16 "
Main steam pipe, diam.................10 1-4 "
Stroke of H.P. valves...............9 ins.
" " I.P. " ....9 5-8 "
" " L.P. " ....8 "

Air pump, diam...............26 ins. by 21 11-16
Cooling surface, two condensers...11,030 sq. ft.
" " auxiliary condensers
1,302 " "
Propellers.........2, 4 manganese bronze blades
Diameter.....17 ft. 8 1-2 in. Boss diam., 55 ins.
Pitch mean..............................16 ft. 3 "
Projected area.............................88 sq. ft.
Developed area.............................102 " "
Pitch ratio.....................................0.92
Boilers, type ....Niclausse water tube
Number...16
Elements, number.................................208
" length......................8 ft. 6 7-16 ins.
Tubes, diameter.....3 1-4 outside. 2 15-16 inside
" length......................7 ft 10 1-2 ins.
Grate, length..7 ft.
" width..................................7 ft. 6 7-8 ins.
Total grate surface.........................846 sq. ft.
Total heating surface ....26,992 " "
$\frac{H}{G} = 31.9$
Working pressure..........................300 lbs.

main condensers, and has a cooling surface of 1,302 square feet. The casing of this condenser is of cast brass instead of the sheet brass in the main condensers.

The following steam pumps are fitted:

2 auxiliary air pumps for main condensers.	10	x	18			ins.
4 main feed pumps........................	9	x	7	x	9	"
4 auxiliary feed pumps..................	9	x	7	x	9	"
2 hot-well pumps	6	x	7¾	x	8	"
2 water-service pumps	5½	x	4¾	x	5	"
2 crank-pit pumps	5¼	x	4¾	x	5	"
4 bilge and fire pumps..................	9	x	6	x	9	"

Besides these pumps there are the oil pumps, etc. One large

THE MESS'OUDIJEH AS RECONSTRUCTED.

feed-water heater is placed on the forward engine-room bulkhead in the first fire room.

The propellers, which are two in number, have each four blades, and have a diameter of 17 feet 8 1-2 inches, and a mean pitch of 16 feet 3 inches, giving a pitch-ratio of 0.92. The bosses are of gun-metal and the blades of manganese bronze.

Steam is furnished by a battery of 16 Niclausse water-tube boilers, designed for a working pressure of 300 pounds, and arranged in two groups in four fire rooms. Each boiler has thirteen elements of 18 tubes, making a total of 208 elements and 3,744 tubes, the latter having an outside diameter of 3 1-4 inches and an inside diameter of 2 15-16 inches, this giving a thickness of 5-32 inch. The length of tubes is 7 feet 10 1-2 inches. The boilers are fitted with automatic feed valves, automatically closing fire doors, and balanced ash-pit doors. The total grate surface is 846 square feet, and the water-heating surface 26,992 square feet, giving a ratio of heating surface to grate area of 31.9 to 1. The boiler rooms are arranged for forced draft in closed stokeholds, but are not air-tight. The four blowers which provide the required air pressure are located over the protected deck.

On her official trial this old ship, which originally made only 13 knots, easily exceeded 17, with an indicated horsepower of 11,135, a performance which reflects great credit upon the builders who undertook the very serious task of reconstruction.

ELECTRIC STEERING.

BY GEORGE E. WALSH.

The saving of space in every possible way is the leading problem of every marine architect, and with modern highly complicated machinery for eliminating hand labor and clumsy operations the work of economizing space in the engine room requires special training. The chief advantage claimed in favor of liquid fuel or coal briquettes for marine use is the smaller space which they occupy in the fuel bunkers, and the same applies with equal force to electrical apparatus as an auxiliary power for operating cranes, winches, lights, bulkhead doors, and steering gear. Every modern ship is to-day provided with its electrical plant for some one or more of these auxiliary purposes, and the question of utilizing the current for additional machinery is receiving practical demonstration every day. Such new steamers as the *Baltic* indicate the extent to which electricity is utilized on modern products of the shipyard. Not only is the fuel handled by electric cranes and buckets, but all deck cranes and winches are electrically worked, and bulkhead doors, steering apparatus, signal lights, and fog horns are similarly operated. Cabins and state rooms are lighted and heated by electric power, and even the cooking in the kitchen is performed by this agency. Altogether, the use of electricity is so general that every part of the ship is wired, and standing on the bridge or in the pilot house the captain can keep in direct communication with every officer and engineer. Automatic signal lights keep him informed of the condition and progress of his ship. The log and lead automatically register on a small dial before him the speed of the ship and the depth of the water, while red and white lights in another row show him whether bulkhead doors are opened or closed. By touching a button he can close the bulkhead doors singly or in series, and they remain closed until released by him. The proper signal lights on the ship are also indicated by small colored lights in the pilot room so that any mistake or oversight of a subordinate is immediately made manifest to the navigator. There is, in fact, in the pilot house or on the bridge, such a complete arrangement of electric lights and buttons that the captain knows absolutely the condition of every important part of his ship, and he has such complete control over its varied and complicated mechanism that in an emergency he could act instantly and intelligently to save the ship.

All of this highly-developed mechanism has been the direct result of introducing electricity on shipboard. Without it there would be little chance of placing such absolute control of the ship in the hands of the navigator. The further extension of electric control in warships might be mentioned, for guns, turrets, torpedo tubes, and ammunition hoists are nearly all operated to-day by electric power. The economy in space through the use of electric current on warships amounts to nearly 20 percent of the whole space available for machinery and operating devices. A modern battleship would have to be increased greatly in size to make it equally efficient if electricity were entirely removed.

In the development of electric control of mechanism on shipboard that of steering has probably been slower than many others. Owing to many difficulties electric steering apparatus has gone through a long stage of evolutionary development, and it is not until comparatively recently that marine architects have adopted it generally. Electric steering devices were designed nearly twenty years ago, but they were not adopted by shipbuilders. There is still to a certain extent a difference of opinion in regard to the advantages of electric steering, and a considerable lack of uniformity of devices employed.

One of the first of the ocean steamers to receive a complete steering unit was the North Atlantic liner *Finland,* of the Red Star line. This steamship, of 13,000 tons, with a speed of 17 knots per hour, is equipped with an electric steering gear in which a 60-horse-power motor of 110 volts is mounted on a Brown tiller. This steamer was built by the William Cramp & Sons Ship and Engine Building Company, of Philadelphia, and the steering apparatus was the first ever extensively employed in this country on a ship of any considerable size. Before the *Finland* was equipped a number of ships had been fitted with auxiliary electric steering apparatus to take the place of hand steering gear, and also for emergencies when the steam gear should break down. As an auxiliary the electric steering gear proves of the greatest value, and it is only necessary to connect the motor driving the rudder to any one of the ship's dynamos. This enables the ship in an accident to proceed under full speed, and not slow down, as is necessary when resort to hand-gear steering is adopted.

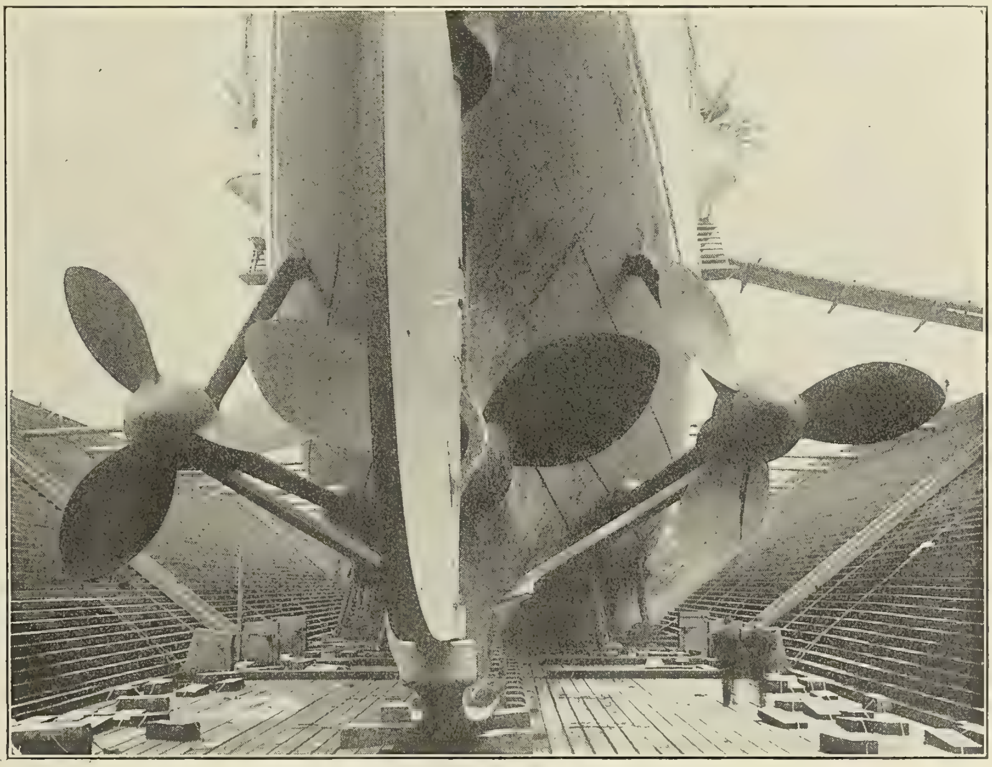
The ordinary auxiliary, or spare electric steering gear, is generally composed of a motor generator of 2 Kw. capacity connected directly when needed to the ship's dynamo. There is an automatic following-up gear, and a steering column located on the bridge. Steering by this method in times of trouble with the ordinary steering apparatus has been quite universally adopted on the older ships where an auxiliary device was needed for emergencies.

The perfected steering apparatus of the new ocean steamships, war vessels, and sea-going steam yachts consists of a motor geared to the rudder and connected by wire to a special electric generator or ordinary ship's dynamo used for miscellaneous purposes. The current, through two field windings wound in opposite directions, enters the steering wheel house, so that the mechanism can be controlled entirely by the man at the wheel. When the wheel is turned in one direction, a rheostat arm is shifted, and a larger current flows in one field winding and causes the rudder to move in the desired direction. In some of the large ocean-going steam yachts a quadrapolar motor of the enclosed type drives a left- and right-hand screw which connects to a crosspiece on the rudder post by links. By turning this screw the rudder is operated. If the electric current should fail, the steering could be done by hand. The steering wheel, when rotated through twelve revolutions, turns the rudder a distance of 80 degrees, and a switching device then automatically cuts off the current to prevent any further movement when the extreme positions are reached. The motor drives the screw through spur gearing and a claw clutch. The motor is direct current, series wound, and provided with a brake which is held off by an electro magnet. As the brake is held on by a stiff spring, the rudder is always at rest when the current is cut off. A small metal disc is geared to the screw, with two switch arms mounted on it to show the position and movement of the rudder. The motion of the arms on the disc is exactly the same as that of the screw to which they are geared, and it is impossible to show anything except the actual position of the rudder at any time. Nothing except the complete derangement of the screw could make the disc reading incorrect.

A number of ship's steering devices to be operated by electricity have been invented and practically demonstrated. The Earl of Crawford's yacht *Valhalla,* 239 feet long and with a tonnage of 1,490, has a steering apparatus similar to the above. The Russian cruiser *Variag,* which met with such a sudden fate early in the present war, had an electric steering apparatus in which the motors were directly geared to the rudder. A number of the ships of the Baltic squadron, now on its way to the Far East, have also electrically-operated steering devices, while some of our newest ships for use on the Pacific coast are similarly equipped. The tendency is toward electric steering, because of the economy of space and simplicity of operation.

A good many ship builders and ship owners have been unwilling in the past to adopt electric steering exclusively because of a lack of practical demonstration of its efficacy. This deficiency is now being partially supplied, and electricity is being adopted more generally for steering as in all other departments. As an auxiliary for emergencies, the electric steering apparatus is the most popular and serviceable yet invented. It can be installed easily and cheaply on any ship that uses one or more dynamos for operating cranes, winches, electric lights or other modern warships and ocean steamships, so electric steering devices are proving the most economical and desirable in nearly all cases where they have been practically tested.

As a final field in which electric steering apparatus has been utilized with success, mention should be made of the torpedo craft. These little engines of war are compressed into as small a space as possible, and any power that will steer or drive them through the water with automatic regularity and certainty is bound to receive attention. Automatically-steered electric torpedoes and torpedo boats have been tested time and again. So well has electricity been adapted in this field that a craft can be started from a given point and be made to travel around a distant point and back again without carrying a human soul. The electric steering apparatus performs the whole work, operating automatically by a simple mechanism. Torpedo boats thus equipped can be controlled from a given station by wires and made to manœuvre around a hostile fleet. As a step in advance of this, we have the torpedoes controlled by wireless electricity. According to the devices thus employed, the torpedoes can be launched from some unseen land station and directed through the water by a most circuitous route to attack a vessel in the open seas. Thus electricity in one form or another promises to improve the operation of our warships and implements of war, and to make the control of ordinary merchant ships more satisfactory than ever, as they sail the high seas on their missions of peace.



THE STERN OF THE TRIPLE-SCREW CRUISER COLUMBIA.
(Photo by W. H. Rau.)

machinery. The cost of operating such an auxiliary installation is nothing except during the time of working, and the wiring can be arranged so that no interference with the regular steam steering need be made. Electric steering is as reliable to-day as any other method, and much simpler and cheaper than steam. It is cheaper than steam, it is cheaper than any other power because there is no waste of energy when the motors are not in operation. There is a saving of space because the motors are attached or geared directly to the rudders, and there is little internal mechanism other than the regular dynamo used for general purposes on the ship. Where steam pipes are used the loss through condensation is quite a considerable item. As electric ventilators, search lights, and arc and incandescent lights are the most efficient yet installed on

The Columbia in Dry-Dock.

We present herewith a picture of the stern of the United States protected cruiser *Columbia* in dry-dock, showing the arrangement and size of the three propellers by which the ship is driven. The *Columbia* has a displacement of 7,350 tons, a length of 412 feet on the water-line, a beam of 58 feet 2 1-2 inches, and a mean draft at normal displacement of 22 feet 6 1-2 inches. On trial she developed 18,509 horsepower and a mean speed for four hours of 22.8 knots, this giving her at that time the record in cruiser speed, not only for our navy, but for all the navies of the world as well. She was the first ship of any importance to be fitted with triple screws.

SHIPBUILDING IN SCOTLAND IN 1904.

BY BENJAMIN TAYLOR.

This has not by any means been a record year in the Scotch shipyards, but the total of tonnage launched has turned out greater than was at one time anticipated. The total of the Clyde has been 234 steamers of 382,716 tons, and 80 sailing vessels of 33,089 tons, in all, 314 vessels of 415,725 tons as compared with 277 vessels of 446,869 tons in 1903. This is a shortfall of 31,144 tons on the year, but that is nothing compared with Belfast, where the output has been only 76,114 tons, as compared with 155,200 tons in 1903. This decrease at Belfast is due to the slackness at Harland and Wolff's yard, where no more monster liners have been built, either for the Morgan combine or for the German companies. On the Clyde, the largest producers have been Russell & Company, Port Glasgow, with 13 steamers of 73,689 tons; the next Charles Connell & Company, with 10 steamers of 40,895 tons; and the third, Barclay, Curle & Company, with 10 steamers of 36,408 tons. Russell & Company's output is the largest in the world this year, not excepting the American Shipbuilding Company with its five yards. The next largest producers to Russell & Company in Great Britain are Swan-Hunter and Wigham-Richardson, Tyne, with 59,099 tons, and William Gray & Company, Hartlepool, with 57,357 tons. Nearly all the Scotch shipbuilding is on the Clyde, which has some 50 building yards of all sizes, capable of turning out expeditiously every description of floating craft from barges to battleships. There are also a few busy yards at Leith, Dundee, and Aberdeen. Taking the 1904 output in the United Kingdom at 1,401,200 tons, it will be seen that the Clyde is responsible for nearly one-third of it. The work, however, has been pretty unevenly divided in 1904, and some of the builders have fared badly while others have done well. A good deal of work remains on hand, but the prospects for 1905 are uncertain.

Just at the close of 1904 one of the most interesting products of the year was launched from the yard of Alexander Stephen & Sons (Limited), namely, the new turbine steamer *Virginian,* of 11,200 tons, for the Allan Line. The *Virginian* is sister ship to the *Victorian,* launched by Workman, Clark & Company, Belfast, in August, and at present fitting out for sea, and they will be the first turbine liners to engage in the cross-Atlantic service. Both vessels will be placed on the Canadian mail and passenger service from Liverpool, the *Victorian* sailing on her maiden voyage to Halifax, Nova Scotia, and St. Johns, N. B., on March 23, and the *Virginian* for the same ports on April 6. These vessels mark a notable advance in the progress of the steam turbine as applied to ocean steamers. The *Virginian's* dimensions are 540 feet length over all, 60 feet beam, and 41 feet depth. She has been constructed under the supervision of the Allan Company's representatives, to the highest class in the British Corporation, and to the passenger requirements of both the British Board of Trade and the American laws. She has accommodation for 1,650 passengers, 470 first-class, 240 second-class, and 940 third-class. The vessel has a poop, long bridge, and forecastle, with large houses in the wells between the hatches, the tops of the poop and houses being arranged as promenades for passengers, and sheltered by boat decks, which again form promenades sheltered by awnings. On the bridge deck is a long deck house containing first-class state rooms, with a wide alleyway on each side; above is the promenade deck with deck houses containing the first-class music and other saloons, sheltered by the boat deck, which is itself a wide promenade having the officers' quarters and navigating bridge at the fore end, and on each side a range of boats the full length of the deck. The steamer is specially designed for the conveyance of the Canadian mails and passengers, five decks being fitted up for their accommodation, but she has also considerable cargo space in the holds fore and aft. The first-class dining saloon, at the fore end of the bridge, has accommodations for 200 persons. The decorations are Georgian style, the paneling of mahogany, toned to a deep color relieved by inlays. A large and airy nursery has been provided for younger passengers. The second saloon, on the main deck, is arranged to seat over 200 passengers, and is pleasingly decorated. In the 'tween decks forward and aft of the cabin passengers are state rooms for the third-class passengers. The deck below is also fitted up with state rooms for the same class, but with portable divisions, so that when not required these rooms can be removed. The cabin accommodation is heated throughout by steam, so arranged that each individual passenger can modify the heat to suit himself. Electric light is fitted throughout, and there is also an installation of the Marconi telegraph. The turbines, which are being supplied by the Parsons Marine Steam Turbine Company (Limited), are to drive the vessel at a high rate of speed. Steam of high pressure will be supplied to the turbines by nine single-ended boilers fitted with forced draft. The boilers and auxiliary machinery have been supplied from the engine works of the builders, Alexander Stephen & Sons (Limited). The turbine machinery is not yet in a condition to describe, but will be rapidly completed. Mr. Nathaniel Dunlop, senior partner of the Allan Company, says that in adopting the turbine method of propulsion they were aware that for ocean navigation it would require important and special adaptations, owing to the enormous power to be developed, and the need of great stopping and reversing power for manœuvring purposes. Mr. Parsons examined the problem and satisfied both himself and them that it could be solved. They had no hesitation in accepting his assurance, and nothing has occurred in the process of construction to disturb their confidence in the system. He made this statement because a paragraph appeared some time ago in the American press to the effect that the turbines had not answered the expectations of the Allan Line, and had not come up to the contract power. That statement was actually issued before the turbines were made, and before any trials of their power were possible. The turbine promised many advantages to travelers by sea, its noiseless and uniform motion imparting a corresponding measure of steadiness to the ship in heavy weather. The speed, too, of these turbines on the Atlantic would reduce the time at sea, and, together with the shorter mileage of the Canadian route, and its land-sheltered navigation on the Canadian side, should make it a favorite line of travel to and from the American continent.

Also at the close of the year, another turbine steamer was launched, viz., by the Fairfield Shipbuilding and Engineering Company (Limited), the twin-screw turbine yacht *Narcissus,* for Mr. A. E. Miller-Mundy, of Shipley Hall, Derby. This vessel is 245 feet long over all, 27 feet 6 inches wide, and 16 feet 3 inches deep to the main deck, and has a Thames measurement tonnage of 782 tons. She has been specially designed by the Fairfield Company, and constructed by them in a most substantial manner, in conformity with the requirements of Lloyd's highest yacht class. Great attention has been paid to form, as well as to the lines of sheer, the contours of stern and cutwater, and also to the placing of masts and funnel, so as to secure the utmost of symmetry and grace. She has been designed with a continuous main or weather deck with cabin deck below forward and aft, a long deck house covered by a shade deck amidships, and rail-high forecastle forward. On the shade deck are the captain's room and chart room, with navigation bridge above. In the forward part of the deck house, on the main deck, is a handsome drawing room lit by large square plate-glass windows. This apartment measures about 14 feet square and will be warmed by an open coal fire. Aft of the drawing room is the main entrance leading to dining saloon and owner's private apartments on the cabin deck, as well as to the drawing room and smoking room. The central deck house is broken by a convenient cross passage from which a ladderway ascends to the shade deck. This passage renders communication easy from side to side without having to go around the deck house, as is the case in so many large steam yachts. The engine hatch measures only 14 feet by 8 feet, as no part of the machinery extends above the main deck. In this casing is the main starting and manœuvring platform. Abaft the engine casing is a large deck house containing the after entrance leading to cabins on the deck below. The after portion of the main deck, clear of the shelter afforded by the shade deck, is occupied by promenade space. On the cabin deck the forward part is taken up by a spacious forecastle, fitted up for 18 seamen and firemen. Immediately aft of the crew space are the officers' quarters and mess room and the owner's private cabin with valet's room. Aft of this is the dining saloon, extending the full width of the vessel and occupying 17 feet of her length, and to accommodate 12 persons. A range of six large state rooms with two roomy bathrooms, is situated aft of the boiler, bunker, and engine spaces, while at the after end of this suite are a maids' room and linen rooms. There are coal bunkers to contain 120 tons of coal amidships, the after hold being occupied by the screw shafts and electric accumulators. The whole of the living quarters are heated by a hot-water heating system having a slow combustion furnace placed in a recess off the main stokehold. This system is in addition to the open fires. Throughout the vessel electric lighting is fitted. The *Narcissus* carries two steam launches, one of 27 feet and one of 16 feet in length, together with two cutters, one gig, and one small dingy. The vessel, which marks another step in the application of turbine propulsion to vessels of the yachting fleet, is schooner rigged with two pole masts. She will be driven by twin screws, and the propelling machinery consists of two independent Parsons compound steam turbines, and one condenser. There is one high-pressure turbine on the port side and one low-pressure turbine on the starboard side of the ship, and a reversing turbine is incorporated with each. These two turbines will each drive a separate shaft, with one propeller on each shaft, and the engine room is fitted with appliances for ensuring economy of working. The boilers for generating the steam are two in number, of the cylindrical multi-tubular marine type, constructed entirely of steel, and adapted for a working pressure of 180 pounds per square inch.

Another notable launch of the Christmas season of 1904 was a new P. and O. liner. Barclay, Curle & Company (Limited) launched the twin-screw steamer *Poona,* built for the Eastern and Australian service of the Peninsular and Oriental Steam Navigation Company. The keel of the *Poona* was laid on June 14, 1904, and within eight months from the time the contract was placed she will be delivered complete to her owners. The *Poona* is 496 feet long by 57 feet 3 inches in breadth, by 35 feet 9 inches molded depth, and her deadweight carrying capacity is 10,000 tons. She is classed to the British Corporation highest standard. There is accommodation for first-class passengers in commodious state rooms under the bridge. The officers' quarters are also under the bridge, and the crew are berthed in the poop and forecastle. The arrangements for working cargo include ten large steam cranes, four winches, and five derricks (one for lifts up to 30 tons), to ensure the rapid discharge of very large cargoes. Nos. 2 and 3 holds and lower 'tween decks are insulated for the carriage of frozen produce. The refrigerating machinery is placed in a large deck house on the upper deck in the forward well on the cold-air system, to enable chambers to be kept at a low, uniform temperature. The vessel is lighted throughout with electricity, and the 'tween decks are lighted and ventilated to comply with the Admiralty requirements for carrying troops. Steam steering gear is controlled from the bridge by a telemoter, and is placed directly over the rudder head. The machinery consists of two sets of powerful triple-expansion engines, constructed by the builders, and these are supplied with steam from two double-ended and two single-ended boilers, with a working pressure of 185 pounds. The chairman of the shipbuilding company said that the *Poona* was a duplicate of the *Palermo,* built by them last year, and they had also on the stocks another vessel similar to the *Poona.* Judging from the information they had received about the performances of the *Palermo,* he had not the slightest doubt that the *Poona* would be able to give a good account of herself. Mr. Taylor, for the P. and O. Company, said that at the present moment the company had under construction at various yards vessels aggregating 66,000 gross tons, placed this year to replace older vessels, and were preparing themselves for any contingency likely to arise. Three of the vessels had been placed with Barclay, Curle & Company, which firm has been in existence since 1818, and this year they had turned out the largest tonnage in their history. For a number of years the P. and O. Company were conservative as regards the disposal of their new work, and most of the vessels were built by Caird & Company in Greenock, but one firm could not possibly undertake all their present requirements.

An interesting vessel, and one perhaps of a novel type for Americans, has just completed her trials on the Firth of Clyde, viz., the Indian government troopship *Dufferin,* the largest ship in the world of this class, which was built by Vickers, Sons & Maxim (Limited). The contract with the Indian Government called for a speed of 18.5 knots, and on six runs over the measured mile at Skelmorlie, on the Clyde, the actual rate attained was 18.9 knots. These six runs followed upon a series of trials at progressive speeds, for the information of the builders, and gave uniform results. Four of the runs were made in 3 minutes 10 seconds, or 3 minutes 11 seconds, and the mean of mean speed was 18.9 knots, nearly half a mile over the contract. This was realized with the engines making an average of 117.8 revolutions and indicating 9,975 horse power. The ship, on a six hours' contract run, gave the following mean results: Steam pressure at the boilers, 179 pounds; at the engines, 178 pounds; revolutions of starboard engine, 115.2; of port engine, 116.3; power indicated by starboard engine, 4,992; by port engine, 4,889; collective power, 9,881 I.H.P. Circulating, steering, and other manœuvring trials were carried out on the way to Barrow. The *Dufferin* was designed by Sir Edward J. Reed, K.C.B., the consulting naval architect for the Indian Government. She has a length between perpendiculars of 437 feet, a beam of 52 feet 6 inches, and displaces 7,340 tons at 19 feet draft, and accommodation is provided for 1,200 officers, troops, etc. The advance in propulsive efficiency is marked by the circumstance that, although the *Dufferin* is 30 feet longer, and correspondingly greater in displacement, than her immediate predecessor, the *Harding,* the same speed has been realized without material increase in engine power. The *Dufferin* differs little in construction and internal arrangements from the first-class modern merchant ship, but is designed with due consideration to adoption as an armored cruiser, and thus will be provided with eight 4.7-inch q. f. guns and eight 3-pounder q. f., the largest size of searchlight projector, large magazines and armory under the water-line, and other similar auxiliaries. There is a cellular double bottom, within which may be carried 800 tons of fresh water, and there are distillers for making 35 tons per day. She is built of strong scantling with four complete decks and a boat or promenade deck amidships extending about half the length of the vessel. There are a large number of water-tight compartments, and for the first time in a troopship has been introduced the Stone-Lloyd system of control for water-tight bulkhead doors. By this system all the doors can be closed by hydraulic gear from the captain's bridge, though any one door may be closed from several positions, while automatic arrangements are provided so that the flow of water into any one compartment would at once close the door of communication from such compartment to others. At the same time, a bell is rung at the door to give sufficient warning to any one in the compartment at the time of the impending closure. Teak has been used throughout for decks, etc., and ventilation has had primary consideration. The vessel has twin-screw, triple-expansion engines, the cylinders being 30 inches, 47 inches, and 75 inches in diameter by 48 inches stroke, and in their design large surfaces have been provided to ensure the maximum of efficiency with the least possible likelihood of trouble. There are four double-ended boilers.

Mr. Erwin S. Cooley has just been commissioned a second assistant engineer in the United States revenue cutter service, and is at present attached to the U. S. S. *Dexter,* stationed at San Juan, Porto Rico.

THE NEW THAMES PASSENGER STEAMERS.*

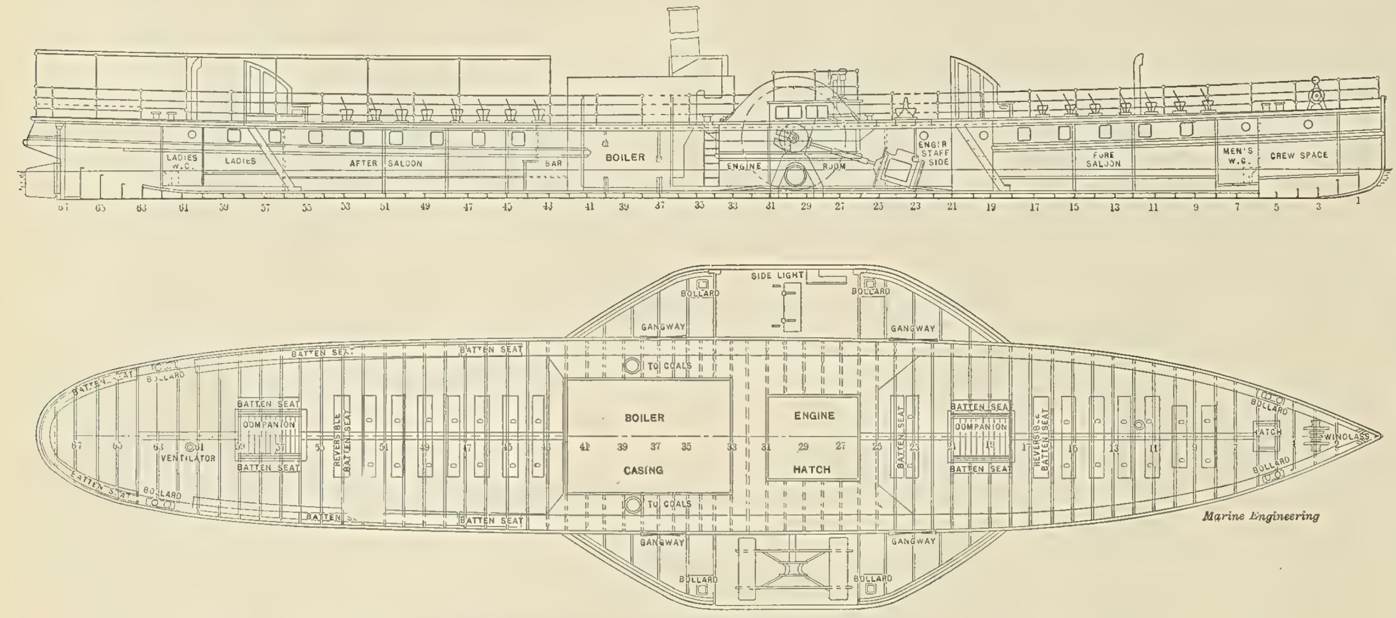
Since the discontinuance of operations by the Thames Steamboat Company, the question of a passenger steamboat service on the river has been frequently mooted and as often discussed but in a somewhat perfunctory manner by the London county council, without any unanimous decision as to the necessity for such a service, until within the last six months, during which time it has been decided that such a service shall be established, the boats employed in it to run between Hammersmith and Greenwich.

Consequent on this decision it was agreed by the council to invite a tender for the construction of the proposed fleet of steamers, which was to be 30 in number, the proposed design of the boats to accompany the tender for their construction.

So far as the type of boat for the intended service was concerned, the London county council, after the fullest consideration of all the conditions under which that service was to be carried on, concluded that the best kind of boat would be that propelled by paddlewheels; the Thames river service being peculiar, in that its tide, which rises and falls twice daily as much as 18 feet, limits the height above water of any part of the boat's structure or fittings, such as stanchions, awnings, etc., to 12 feet 6 inches; the numerous bridges that have to be passed on the Hammersmith service would be fouled at high water, and as the tide recedes so much at low water, the boats would be in danger of getting aground if drawing more than 2 feet 10 inches to 3 feet. As far as their speed is concerned, the frequent stoppages caused by the crowded state of the river precludes a high engine power being employed, and the limited draft of water, together with the stringency of the Thames conservancy laws as to "steamers' wash," had to be considered in deciding on the design and dimensions of the vessels.

Taking the foregoing considerations into account, the London county council on the 27th of last July invited the Thames Iron Works Company to tender for the construction and fittings of 30 steamers, or any lesser number as low as 10, as they could not accept a variety of designs. This company could lay down and build in its shipyard as many as 20 hulls of such vessels, and construct all the engines for the whole fleet at the Greenwich engine works; so prepared a design to fulfil the requirements of the council, which were as follows: Length not to exceed 140 feet, but less preferred; breadth to be left to the builders; depth molded, 7 feet; draft of water not to exceed 2 feet 10 inches, with 40 tons weight on board, representing passengers, coal, crew, etc. The speed with this load on a three hours' trial to be 13 miles an hour, or a 12 mile working speed when on service. The engines to insure this speed—under onerous penalties—to be of the compound surface-condensing type, their power being left to their builders to determine.

To meet these conditions the following dimensions and particulars were adopted: length, 130 feet; beam, 16 feet 6 inches; and loaded draft 2 feet 10 inches, the intended working speed at that draft being 12 statute miles per hour. The motive power to attain that speed in regular service is to be obtained in each boat by an engine of the diagonal two-cylinder compound type situated forward of the shaft and driving a pair of paddlewheels 10 feet 6 inches in diameter over the floats. The engine cylinders are 16 and 31 inches in diameter with a common stroke of 30 inches, the working pressure being 115 pounds per square inch. When running at a speed of 55 revolutions per minute it is expected that 270 indicated horsepower will be developed.



INBOARD PROFILE AND PLAN OF NEW THAMES PASSENGER STEAMERS.

The engine, it will be seen, consists of three A-shaped cast-iron frames carrying the main crank-shaft bearings, the frames being securely bolted at their feet to seatings worked up from the vessel's frames, and at their heads to the sponson beams as usual. The cylinders are placed as shown, in an inclined position forward of the paddle shaft, the high pressure being on the port side of the vessel; the piston-rod guide bars, which are of forged steel, on both cylinders forming the connections between them and the main bearing frames. The main crank shaft is of wrought steel 6 3-4 inches diameter, forged in one piece, having a coupling flange at each end, as shown, for connecting up to the paddlewheel shafts, which are also of steel.

The surface condenser, which is cylindrical in form and of light construction, is placed athwartships as shown, between the legs of the main bearing frames, its shell being built of Muntz metal plates riveted together and joints sweated, and its water ends of copper; the tubes, which are of brass, will be fitted into the tube plates with screwed glands and tape packing. The cooling water is supplied by an independent centrifugal circulating pump, a small auxiliary air pump being driven off the same engine. The main air pump, which is of the Edwards type, and which will be seen in the plan and side elevation, is placed aft of but on the center line of the high-pressure cylinder, is driven by link and lever gear off the high-pressure connecting rod, the feed and bilge pumps being also actuated by the same gear. The paddlewheels, which are of the feathering type, have arms and rims of wrought

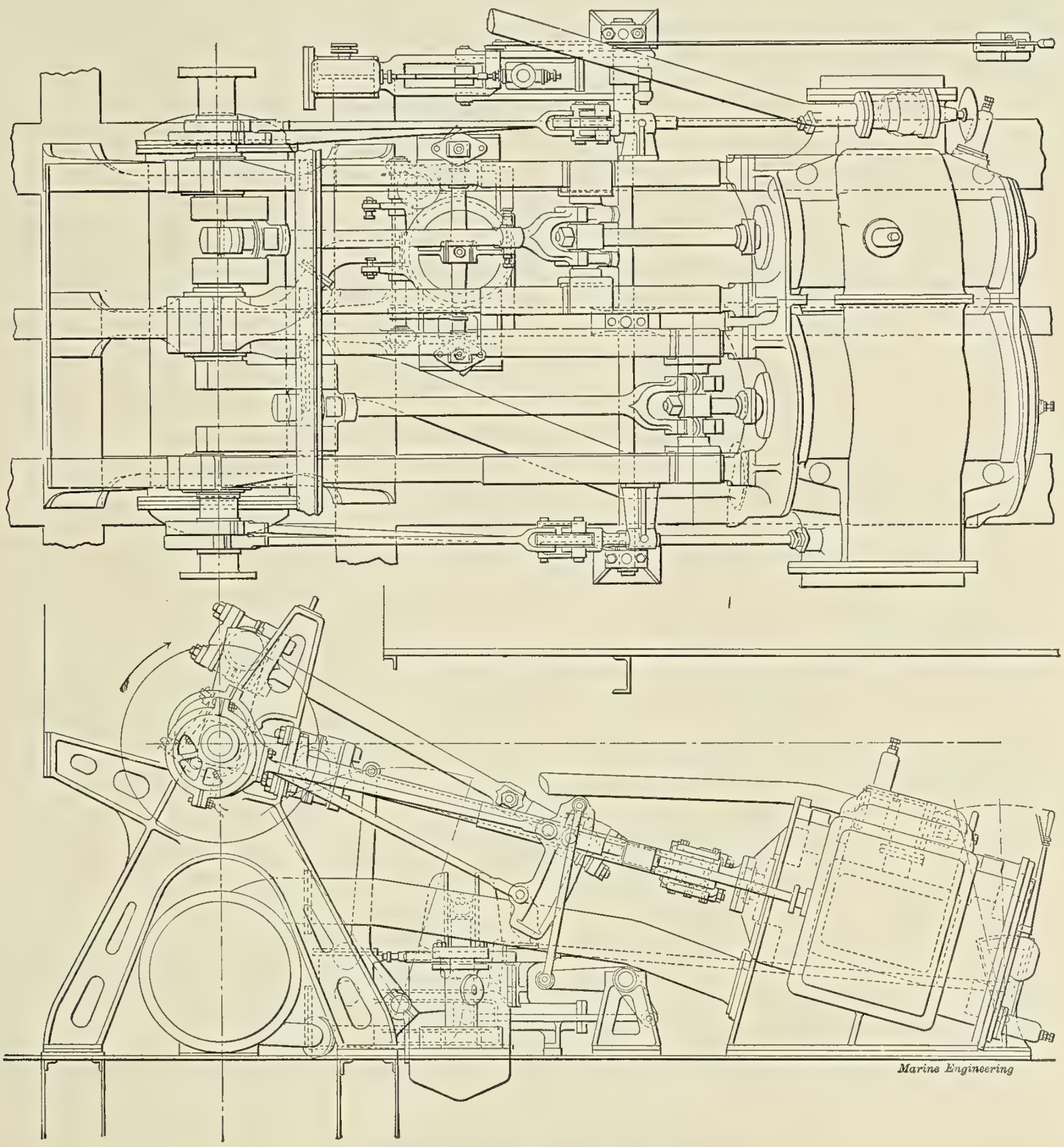
*Engineer, London.

iron, the wheel bosses being of cast steel, secured to the paddle shafts by steel pins. The floats are of American elm, the working pins of steel cased with gun metal, and the arm bosses and radius rods bushed with lignum vitæ.

Steam is supplied by an ordinary marine cylindrical boiler of the return-tube type, 9 feet diameter by 8 feet 9 inches long, having 700 square feet of heating surface and 25 square feet of fire-grate area; Howden's system of forced draft being applied, with a special spark arrester uptake. An independent fan and engine

construction of the fleet of 30 boats has been divided between three firms, viz., The Thames Iron Works Company, of Blackwall; Messrs. J. I. Thornycroft & Company, of Chiswick; and Messrs. Napier, Miller & Company, on the Clyde; each of which will build 10 hulls, the first-named firm contracting to build both the hulls and engines, and the last mentioned 20 sets of machinery in addition to the 10 hulls.

So far as the boats to be built on the Thames at Blackwall are concerned, the work is already being rapidly pushed. The steel



THE INCLINED COMPOUND PADDLEWHEEL ENGINES.

are placed in the stokehold for the supply of air to the furnaces through the Howden apparatus, which delivers it to the fires considerably raised in temperature. For the ready handling of the main engine a Brown's steam starting engine is fitted—seen in illustration on the port side of the plan—having a by-pass valve to the low-pressure cylinder receiver. A silent blow-off to the condenser is also fitted to carry off any steam that may have accumulated during brief stoppages at the river piers. The engine-room equipment also includes a steam steering engine, an electric-light engine and dynamo, an auxiliary feed engine, and a large reserve feed-water tank.

We give a profile and plan of the vessels, as approved by the London county council for the proposed Thames passenger service, showing the arrangement of seating on deck, and the extent of saloon space below, for the accommodation of passengers. The material for both hulls and engines is coming to hand. The deck planking is cut and seasoning, but it is not thought possible, under present weather conditions especially, that the fleet can be got ready for its intended service by May 1, as intended.

At an auction sale on the 14th of March, the shipbuilding plant on Shooter's Island, New York harbor, formerly owned and operated by Messrs. Townsend & Downey, was sold to the Colonial Trust Company for a total of $516,000. The plant is valued, at present, at about $2,000,000, while the liabilities under the assignment amounted to $870,000. It has not yet been announced whether or not the purchasers intend to operate the plant, but it is probable that some scheme for operation will be evolved at an early date.

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The edition of the May issue of Marine Engineering comprises 5,500 *copies. We have no free list, accept no return copies and issue only enough to supply the regular demand, so that the* 5,500 *copies represent legitimate circulation.*

The American merchant marine is still, like Mr. Micawber, "waiting for something to turn up."

The Transatlantic Yacht Race.

Within a few days the eleven yachts destined to take part in the sailing race across the Atlantic, for the cup offered by the Emperor of Germany, will begin to assemble and get into shape for the event. Of these yachts, it is interesting to note that six were built in the United States and the remaining five in Great Britain; while eight of the total number sail under the American flag, two under the English, and a single one under the German flag. The variation in size is quite considerable, ranging from 86 feet in length in the case of the American *Endymion,* to 240 feet for the English *Valhalla;* while in net tonnage the range is from 86 tons in the case of the American *Fleur-de-Lys,* to 648 for the big Englishman above mentioned. Nearly all the yachts are of very recent construction, there being only one which was built prior to 1890; that one is the famous *Sunbeam,* owned by Lord Brassey, and launched more than thirty years ago.

The problem of picking the winner is one which has engaged the attention of a great many yachting experts, and there is by no means any similarity of result. If the weather should prove to be very heavy, it seems to be supposed that the largest ships would have the best chance. This would appear to favor the *Valhalla,* which is more than 70 feet longer than her nearest competitor, and of more than double the tonnage. On the other hand, this ship is square rigged, and, therefore, would be unable to sail so good a race in case a large proportion of the weather showed head winds. If the latter sort of weather be encountered, some experts seem to think that the *Atlantic* will probably make as good a showing as any. The *Atlantic* is a three-masted schooner measuring 135 feet in length, and is of 206 net tons. Very light winds would probably favor the lighter of the vessels indicated, but it is anticipated that the race will not at all resemble the sort of drifting match which has been too frequently the spectacle in connection with the races for the *America's* cup. The record time in crossing the Atlantic under sail, under such conditions as this race will show, is somewhere near twelve days. It may be expected, therefore, that one or more of the ships will cross in under fifteen days, while it is not at all unlikely that the last one, barring accidents, will be able to make the passage in less than three weeks. A great deal of interest is centered in the race, much more so, in fact, than would probably be the case with the ordinary "marine circus," as one of our correspondents has designated the international races off Sandy Hook.

The Naval Conflict in the Far East.

It is with considerable trepidation that we attempt to discuss the situation in the China Sea as between the Russian and the Japanese fleets, which at the present writing seem to be practically within striking distance of each other. The situation will be developed so very rapidly when once the squadrons are within actual touch of each other that what we are writing to-day may become ancient history to-morrow, or perhaps be totally discounted by a sequence of events which do not at all bear out what appear to be the present probabilities of the case. As it looks at present, however, the two squadrons have a strength almost equal to each other, so far as pure *materiél* is concerned; for the Russians have four modern battleships of a very powerful type to oppose to the four which appear to be left from the six with which the Japanese started the war, and they have, moreover, one first-class and two second-class battleships, together with several armored cruising vessels of an obsolete pattern, to oppose to the Japanese vessels of the second rank, which consist with one exception of high-speed armored cruisers of excellent design and considerable power. So far as tonnage of armored vessels goes, the Japanese are ahead, having a total of twelve ships amounting to 128,000 tons; while the Russians have apparently only ten ships amounting to about 110,000 tons; but the fact that a large proportion of the Russian ships are of the heavy fighting variety, designed to give and receive the heaviest blows, while so large a proportion of the Japanese are of the armored cruiser type, excellent in themselves, but unable to withstand successfully a heavy attack from the powerful ordnance carried by the five leading ships of the Russian fleet, renders the situation considerably more doubtful than would be the case were it possible to base an estimate on tonnage alone.

One point which has received a great deal of attention from the press is the question of speed as between the two fleets. It is reported that the Russian ships are badly covered with barnacles and other marine growths, and that their speed has consequently been reduced to such an extent that they will scarcely be able to do more than eight or ten knots; whereas the Japanese ships, although they have been out of dock for a long time, have until within the last few weeks been very remote from the tropical waters where these growths are so prevalent, and consequently they probably have much cleaner bottoms, and will be better able to maintain something approximating the rate of speed for which they were designed. This speed in itself is considerably higher in the case of nearly all the ships than is the speed of the Russian vessels, hampered as the latter squadron is by the accompaniment of a number of ships of old pattern and low speed; and the result is that Admiral Togo should be able to accept or decline battle at will, provided he is not called upon to directly defend any of the home ports in Japan.

As the Russians have no means of coaling, now that they are in the China Sea, other than from the colliers which accompany the fleet, some authorities have expected reports to the effect that Togo had let loose his destroyers upon these colliers in order to make it impossible for the Russian squadron to remain longer at sea, or to accomplish much of anything in the way of offensive work. It seems probable, however, that Rojestvensky is quite awake to the situation, and will use every endeavor to protect the colliers, and thus in fact maintain his "communications."

Both squadrons have a considerable number of protected and unprotected cruisers, together with torpedo-boat destroyers, but as ships of this class are totally unable to cope with the heavier fighting vessels, they could be available simply as scouts, or for minor actions not affecting the general result of the campaign. The Japanese considerably outnumber the Russians in ships of these classes, but it is well to note that among the Russian ships is one of the 25-knot cruisers of the *Nowik* class, which is so much faster than anything the Japanese can pit against it that the Russian service in this particular may perhaps prove to be superior to that of their opponents. As soon, however, as the Russian squadron reaches the immediate vicinity of Japan, if that vicinity ever is reached, the Japanese will be able to employ a very considerable squadron of torpedo boats of the smaller types, and her scouting abilities be much improved as compared with what they are at present.

It being quite apparent to outside observers that upon the results of the decisive battle which appears so imminent depends in no small measure not only the future of the present war, but the very future of the Japanese empire, the daily trend of events is being watched with the utmost interest, not only by professional naval and military men and engineers, but by the public at large. Should the Russians succeed in their endeavor to cripple Togo's fleet, it would result immediately in the transference to them of the command of the sea, now held so long by Japan; and would operate at once to isolate the Japanese army on the main land of Asia, cut their line of communications, and perhaps force Japan to make peace on Russia's own terms. If, on the other hand, Togo can succeed in either destroying the Russian squadron, or so neutralizing it as to prevent its menacing the Japanese line of communications, then the land campaign, which has occupied so much attention during the last few months, will be the one which will probably be decisive of the result of the war. In either event, the probability is that directly upon the issue of the naval conflict will depend the question of peace, and the ultimate outcome of a titanic struggle which has been almost without parallel in the annals of history.

A Serious Menace to Navigation.

Several times recently it has been discovered that a ferryboat has left her slip without showing the customary and necessary red and green lights on her port and starboard bows, respectively. Not only this, but the lights did show at the other end of the ship, where they had been set for the previous passage. The danger attendant upon this sort of thing needs no emphasis. Passing craft are accustomed to call attention to such a deficiency by a "two-two" whistle, but it might well be that a serious collision would result before this whistle signal had produced the desired result of procuring a proper setting of the lights.

To obviate the possibility of a mistake of this character some of the newer of the ferryboats plying in New York waters, which are electrically lighted, are fitted with a device by means of which the steering-wheel cannot be unlocked without throwing a switch which makes the necessary contact for setting the forward lights; while at the same time the lights at the other end of the boat are extinguished automatically by the same movement which locks that wheel in place. So necessary is it that this matter be made independent of the human factor—of the "personal equation" of the captain—that legislation is recommended, making compulsory the use of some such automatic device. The question is one of great importance, and of very lively interest to all whose business it is to be afloat in the harbor at night.

ABSTRACTS FROM RULES AND REGULATIONS OF THE AMERICAN BUREAU OF SHIPPING.

EDITION OF 1904.

ARRANGED BY HARRISON S. TAFT.

PART III.

7. When the main longitudinals do not extend into a boiler or engine room space, the auxiliary girders in said spaces should lap at least 3 frame spaces over the regular longitudinal girders, so as to maintain the longitudinal strength of the ship.

8. When the inner bottom plating is worked in and out the liners under the upper strakes should be left short, so as to provide means for ventilating said bottom. With flush plating, holes must be provided well up in the floors and longitudinals for the same purpose.

9. Water-tight floors should be fitted under all water-tight bulkheads.

10. Wooden ceilings when used are to be at least 2 1-2 inches thick. When not used the steel plating is to be 7 pounds heavier than otherwise.

11. Double bottoms should be tested with a head of water 2 feet above the deep load-water line.

12. When brackets are flanged in place of using angle clips, said brackets are to be 2 pounds heavier than otherwise.

28. Hatch Ways and Deck Openings.

1. All freight, engine, and boiler openings on a weather-deck should have plate coamings of not less thickness than the beams to which they are connected.

2. The boiler and engine hatch coamings in steam vessels, where the upper deck is not a hurricane deck, are to stand at least 3 feet above said upper deck planking unless a deck house is fitted over said openings, in which case the height can be 24 inches. When of said 24 inches in height, the weight of the coaming plate is to be not less than 14 pounds for vessels whose second number is under 16,000; and not less than 16 pounds when said number is or above 16,000.

3. The coamings of an engine or boiler opening on a hurricane, bridge, or full poop deck are to stand at least 18 inches above said deck planking.

TABLE 15.—UPPER-DECK FREIGHT HATCH COAMINGS. FORE-AND-AFT CARLINGS FOR HATCH COVERS.

Length of Hatch in Feet.	Height of Coamings Above Deck Planking.	Thickness of Coamings.
Not over 12	$1\frac{1}{2}$ times depth of deck beams to which they are secured.	2 lbs. less than thickness of deck beams to which they are secured.
Over 12 " " 16	Twice depth of deck beams to which they are secured.	Equal to thickness of deck beams to which they are secured.
" 16 " " 20	$2\frac{1}{2}$ times depth of deck beams to which they are secured.	2 lbs. heavier than thickness of deck beams to which they are secured.

Width of hatch in feet	Under 9	9 not over 12	Over 12, not over 16	Over 16
Number of fore-and-aft carlings to support hatch covers.	1	a. 2 or 3	3	Plans to be submitted for approval.

a. Two carlings when hatch covers are made full width of hatch: otherwise three carlings.
This table does not apply to hurricane-deck vessels.
Plans of hatches over 20 feet in length; or in width more than $\frac{3}{8}$ the beam of the deck in way of said hatch on which they are fitted, must be submitted for approval.
When wooden carlings are used the middle one is to be at least 8 inches × 10 inches: side carlings, 7 inches × 6 inches.
Supporting collars with at least 3 square inches of rivet area are to be fitted at each end of the hatch cover carlings.

4. The coal-scuttle hatches on a weather deck are to stand above the top of the decking at least the depth of the main deck beams.

5. The coamings of freight hatches on the second deck of a hurricane-deck vessel need not exceed 18 inches above said deck planking. In other respects they are to be like the upper-deck hatches.

6. Freight hatches over 12 but not over 20 feet in length are to have a portable beam at mid-length, extending from the under side of the coaming plates to the under side of fore-and-aft carlings which support the hatch covers, and are to support said carlings for at least 5 inches of their length.

7. Hatch-coaming deck angles are to extend 1-2 inch above the deck planking.

8. Hatches on the upper decks, second decks of hurricane vessels, are to have rounded corners.

29. Hatch Covers.

They must be at least 3 inches thick. Hatch bars are to be at least of 4-inch by 1-2-inch iron; the wooden battens at least 8 inches by 2 inches. See Table 15 for hatch carlings.

30. Deck Houses and Engine Casings.

1. The plating of a deck house over the engine and boiler room deck openings of all vessels, except in hurricane-deck vessels, is to be at least of 8 pounds when the second number is under 16,000 and said deck house is not over 10 feet wide, or the combined length of said deck openings is not over 24 feet. When either of these two dimensions are exceeded, or the second number is 16,000 and under 25,000, a 10-pound plate is to be used. When said number is 25,000 and above, the plating is to be at least of 12 pounds. The stiffeners are to be equal to the reverse bars and be spaced 30 inches apart.

2. Deck houses fitted on a hurricane, bridge, or full poop deck over the engine and boiler openings, if not over 10 feet in width or 24 feet in length, are to be of 8-pound plate with 2 1-2-inch by 2 1-2-inch angle stiffeners. If said house is over the above 10 or 24 feet, 10-pound plating with 3-inch by 3-inch angle stiffeners is to be used. The stiffeners are to be spaced not over 30 inches apart. 4-inch by 3-inch stiffeners are to be used with all plating over 10 pounds.

3. Engine and boiler casings between decks are to have coaming plates standing 18 inches above the deck planking and they are to equal the thickness of the beam to which they are attached, but they need not exceed 16 pounds. Casing plating above the coaming is to equal that of the upper part of a water-tight bulkhead; stiffeners equal to reverse bars are to be spaced not over 30 inches apart.

31. Masts, Yards, and Bowsprits.

1. Lower Masts. (*a*) When under 24 inches in diameter at the partners they are to be built of two strakes of plating; but if 24 inches or over, of three strakes. Plating at the partners is to maintain its specified weight for 1-2 the length of the mast above and below the partners respectively. The weight of the topmast plating at the heel is to extend for 1-2 the length of said topmast above the heel.

(*b*) The plating at the partners must be doubled above and below the wedging for at least a distance of 1 1-2 times the diameter of the mast at the partners.

(*c*) There must be three rows of stiffeners in the lower masts dividing the circumference equally. If the lower mast is 45 feet or over from the partners to the hounds the stiffeners must extend the entire length of the mast. If said length is less than 45 and not under 35 feet, the stiffeners are to extend from 1-5 the tabulated length from below to 3-5 of the tabulated length above the partners. If said length is under 35 feet they need only extend from the lower edge of the doubling plates at the partners to 2-5 the tabulated length above the partners.

(*d*) All masts should be doubled in way of the lower mast caps and at the fid holes.

2. When the mast of a steamer or of a fore-and-aft rigged sailing vessel is made in one length, and the length from the lower mast partners to the lower mast hounds is 30 feet or more, the stiffeners are to extend above the lower mast hounds at least twice the diameter of the mast at the partners. Doubling plates are to be worked at the hounds.

3. Bowsprits.

The plating should be worked in three strakes when the diameter at gammoning is 24 inches or above. The weight of plating at gammoning is to be carried outboard and inboard of gammoning 1-2 of said respective lengths. There should be a stiffening bar extending from cap to heel at the center of each strake. Doubling plates, in length twice the diameter of the bowsprit at gammoning, should be worked at gammoning. When the sprit is 28 inches or over in diameter at gammoning there should be a vertical web plate inside, equal to the thickness of the plating at gammoning extending outboard and inboard 1-3 of said respective lengths.

4. Yards.

They are to have doubling plates at the slings, said plates being in length not less than three times the diameter of the yard at slings. They should maintain their center weight of plating for 1-4 length of yard on each side of the slings.

32. Sluice Valves, Etc.

1. They should be fitted to all bulkheads except the forward collision bulkhead, with a rod running to upper decks. The forward collision bulkhead is to have a brass stop cock.

2. Sounding pipes are to be galvanized, with doubling plates located under same. They should be fitted to each water-tight compartment.

3. Bottoms from the keel to the bilges should be cemented. Thickness of cement should be such as to cover the heads of all frame and inside strake butt-strap rivets. The top of the inner bottom plating should also be cemented.

4. All sea suction pipes should have stop cocks or valves at the shell plating.

5. Upper-deck scuppers are to discharge overboard. Lower-deck scuppers are to drain into the bilge. Soil pipes extending below the load water-line are to be of iron or steel below said water-line and have shut-off valves.

6. Ventilators of suitable size are to be fitted so as to properly ventilate all spaces not ventilated by skylights, side ports, etc.

33. Wooden Decks and Ceilings.

1. When a wooden deck is laid on an all-fore-and-aft steel deck and the second number is not over 25,000, it may be 1-2 inch less in thickness than otherwise called for; that of a weather deck being not over 3 inches thick and that of a lower deck not over 2 1-2 inches thick.

2. Hurricane, full poops, and bridge decks are to be not less than 2 1-2 inches thick. Lower decks and topgallant forecastles are to be not less than 3 inches thick, when the second number is 10,000 and over, but when said number is under 10,000 the decks may be not less than 2 1-2 inches thick. The planks should not be over 6 inches wide.

3. Upper deck planking, second deck in hurricane-deck vessel, topgallant forecastles, and all margin planks are to be fastened with galvanized bolts through the beams. Hurricane decks, full poops, and bridge decks are to have galvanized screw fastenings to the beams.

4. All decking is to be renewed when reduced to 3-4 of its original thickness.

5. The margin or sheer planks are to be of southern pine, at least 7 inches wide and 1-2 inch thicker than the deck planking.

6. The sides of the cargo holes and between-deck spaces are to have wood battens 2 1-2 inches thick secured with galvanized bolts and nuts to the reverse bars. The bilges are to be close ceiled.

34. Steering Gear.

1. Diameter of chains is to be obtained by the formula:

$$d = .4\sqrt{\frac{D^3}{R}} \text{ where } D = \text{the diameter of the rudder stock;}$$

R = the radius of the quadrant; and d = the diameter of the chain iron; all in inches.

2. Rods, when used, are to be 1-4 larger in diameter than chains.

3. Sheaves are to have a pitch diameter of at least 15 times the diameter of the chains. Diameter of their pins is to be not less than twice the diameter of the chains.

35. Rudders.

The plates of side-plated rudders are to equal in weight the lower plates of bulkheads, with wool filling between them. All rudders are to be arranged so they can be unshipped when the vessel is afloat.

36. Lifeboats.

TABLE 16.—NUMBER OF LIFEBOATS.

Second number........	Under 5,000	5,000 under 8,500	8.500 under 16 500	16,500 and above.
Number of boats......	1	2	3	4

Vessels of American Register must have lifeboats and other equipment according to the United States statutes.

37. Three-Deck Vessels.

1. Said vessels are to be of 18 feet or more in depth, having two or more complete tiers of decks, with hold beams.

2. The sheer strake is to be fitted at the upper deck.

3. Butts of the sheer strake, of the upper-deck stringer, and of at least two bilge strakes, are to be treble riveted for 3-5 length amidships.

4. Engine and boiler casings are to extend from the second to the upper deck.

38. Hurricane-Deck Vessels.

1. The main sheer strake is to be worked at the second deck with an auxiliary sheer strake at the hurricane deck. Coastwise vessels may have their hurricane-deck sheer strake and the shell plating between the hurricane and the main deck of less weight than for an ocean-going hurricane-deck vessel.

2. Tie plates are to be fitted on the hurricane deck; with a reduction in width of same for a coastwise vessel.

39. Full Poops, Enclosed Bridge Houses, Topgallant Forecastles.

1. Second number under 16,500.

(*a*) When the length of said poop or forecastle deck exceeds 1-5 the length of the vessel, the main-deck sheer strake at front of said poop and at aft end of said forecastle is to be increased by 4 pounds for a distance equal to 1-2 the vessel's breadth.

(*b*) When the combined length of said poop and bridge house, of said poop and forecastle, or of said poop, bridge house, and forecastle exceeds 1-2 the vessel's length, the said increase of 4 pounds is to extend for 3-4 length amidships.

2. Second Number 16,500 or above.

(*a*) In place of a 4-pound increase, as above, the sheer strake is to be worked double for the respective distances of 1-2 breadth and 3-4 length amidships.

(*b*) The doubling of the sheer strake is to equal the weight of the strake next below the sheer strake, and is to extend from the upper edge of said strake to the main-deck stringer. The thickness of the enclosed bridge-house plating is to be maintained for 3 frame spaces forward and aft of the ends of said bridge house.

3. Tie plates are to be worked on a topgallant-forecastle and bridge-house deck when the vessel's breadth exceeds 20 feet. They are to be worked on a full poop deck which exceeds 1-5 of the vessel's length or which is 20 feet or more in width at the forward end of said poop deck.

4. Sheer strakes of a topgallant-forecastle or enclosed bridge house whose length is or over 1-5 the vessel's length, and of a full poop whose length is or over 1-4 said length, are to be 2 pounds heavier than the side plating of their respective deck enclosures.

5. When rounded gunwales are used, the gunwale bars on these decks are to be worked so as to form a margin for the deck planking.

40. Raised Quarter and Fore Decks.

1. The scantlings of said decks are to be the same as for a main deck.

2. When the length of a raised quarter deck exceeds 1-4 the vessel's length the depth for determining hold stringers and beams under said decks is to be taken to the top of said deck at its forward end.

3. When the length of a fore or raised quarter deck exceeds 1-4 the vessel's length, the main-deck stringer is to maintain its full width throughout, and must taper for at least 6 frame spaces beyond the break at both ends of said deck to moulding of the frame at its ends. It shall be clipped to the shell. The quarter and fore-deck stringers are also to extend beyond the breaks a sufficient distance to maintain the strength of the vessel.

4. The doubling or increasing of the weight of the main sheer strake is to be the same as for a poop, enclosed bridge, or topgallant-forecastle deck, as above.

5. Raised quarter decks (except when same is worked over the engine and boiler spaces), not over 1-4 the vessel's length, and raised fore decks not over 1-5 the vessel's length need not be plated.

6. Steamers with their machinery placed amidships and with a raised quarter or fore deck, either of which exceeds 1-5 the vessel's length, requiring a steel deck, are to have said deck extending all fore and aft, with bracket plates, or otherwise at the breaks. If said length is under 1-5, the steel deck need not extend beyond the breaks, but the above bracket plates must be fitted at the breaks.

7. When no steel deck is laid on the main deck, one beam space at the ends of a raised quarter, fore deck and enclosed bridge house is to be plated over from stringer to stringer.

8. Plates for securing the ends of the wooden deck are to be worked on the beams at the ends of a raised quarter, bridge house, and fore deck.

9. Sheer strakes at the raised quarter and fore decks are to equal those of the strake next below the main sheer strake, when said strake is not over 14 pounds. If the above said strake is 15 pounds, the raised quarter and fore decks' sheer strakes are to be 1 pound less than said strake, but 2 pounds less if said strake is 16 pounds or over.

41. Freeboard.

TABLE 17.—FREEBOARD.

Depth of hold from top of ceiling to under side of main deck; (second deck in hurricane-deck vessels). Feet...	8	10	12	14	16	18	20	22	24	26	28	30
Freeboard at lowest point of sheer. Inches..........	12	20	27	31½	40	49½	60	71½	78	91	98	112½

The freeboard is to be measured from the actual load water-line to the main-deck stringer (second deck in hurricane-deck vessel) at the lowest point of the sheer.

The minimum freeboard for hurricane-deck vessels may be not less than ½, and for raised quarter-deck vessels not less than ¾ of the above freeboard.

42. Spacing of Rivets.

	Dias.
1. Longitudinal laps and edges of shell plating and of all other plating required to be calked water-tight:	
20 pounds and under..	4
Over 20 pounds..	4 1-2
Center to center of rows..	2 3-4 to 3
2. In all butts, except third row of a treble-riveted butt	3 1-2
Center to center of rows..	2 1-2 to 3
3. Third row of a treble-riveted butt, except otherwise stated........................	7
4. Bar keels, stems, stern frames..	5
Center to center of rows..	2 1-2
5. Laps or edges of water-tight bulkheads; longitudinal laps or edges of a steel deck; longitudinal laps or edges of the inner bottom plating; gunwale bars and similar water-tight work......	4 1-2
6. Water-tight frames to shell and bulkheads..	5
7. Ordinary frames to shell and floors; reverse frames; stiffeners on all bulkheads, engine and boiler casings, shaft tunnels, and deck houses; all stringer plates and deck plating to deck beams; all keelsons and stringer angle bars; and, in general, where water-tight work is not required....	7 1-2

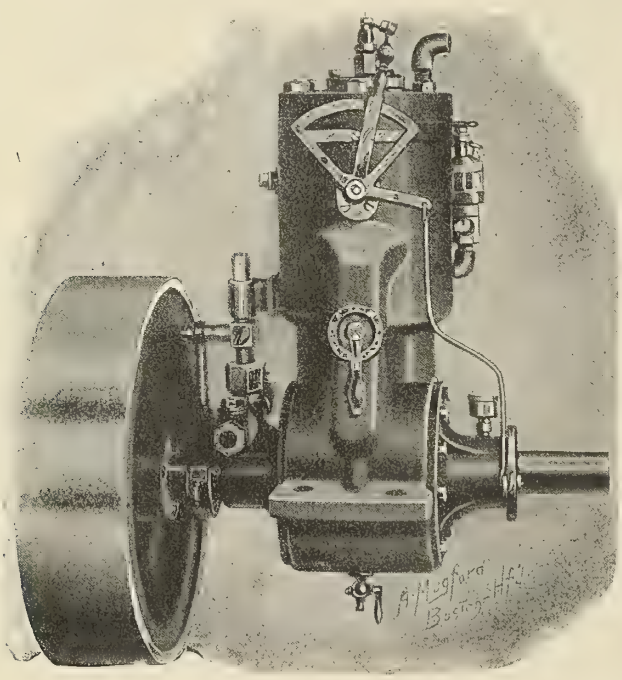
TABLE 18.—AMERICAN BUREAU OF SHIPPING. WIDTH OF BUTT LAPS AND BUTT STRAPS. SPACING OF RIVETS.

	Width of Plate in Lbs.	Diametral Pitch.	10	12½	15	17½ to 20	22½ to 27½	30 to 35	37½ to 40
	Diameter of Rivets in Inches.		9/16	⅝	11/16	¾	⅞	1	1⅛
Width of.	Single riveted butt laps	3½	2	2 3/16	2⅜	2⅝	3 1/16	3½	3 15/16
	Double " " "	....	3¾	4⅛	4½	5	5¾	6½	7¼
	Treble " " "	. ..	5½	6	6½	7	8¼	9½	10¾
	Double " " straps	....	7	7¾	8½	9½	11	12½	14
	Treble " " "	....	10½	11½	12¾	14	16½	18½	21
	Single " " seam laps	....	2	2¼	2⅜	2½	....	....	....
	Double " " " "	6	3½	3¾	4	4½	5¼	6	6¾
	Single " " edge strips	....	4	4½	4¾	5½	6¼	7	8
	Double " " " "	12	6¾	7½	8¼	9	10½	12	13½
Spacing of rivets.	1.—All butts except third row of a triple riveted butt	3½	2	2 3/16	2⅜	2⅝	3 1/16	3½	3 15/16
	Center to center of rows	2½ to 3	...	...	...	...	....	....	....
	2.—Laps and edges of the shell and all other plating required to be caulked. Not over 20 lbs.	4	2¼	2½	2¾	3	3½	4	4½
	Over 20 lbs.	4½	2½	2 13/16	3 1/16	3⅜	3 15/16	4½	5 1/16
	Center to center of rows	2¾ to 3	...	...	...	...	....	....	....
	3.—Seams of water-tight bulkheads; of steel decks; of the inner bottom plating; and of all similar work	4½	2½	2 13/16	3 1/16	3⅜	3 15/16	4½	5 1/16
	4.—Bar keels; stems; stern frames	5	2 13/16	3⅛	3 7/16	3¾	4⅜	5	5⅝
	Center to center of rows	2½	1⅜	1 9/16	1 11/16	1⅞	2 3/16	2½	2 13/16
	5.—Water-tight frames to shell and bulkhead plating	5	2 13/16	3⅛	3 7/16	3¾	4⅜	5	5⅝
	6.—Third row of a triple riveted butt; unless otherwise stated	7	3 15/16	4⅜	4 13/16	5¼	6⅛	7	7⅞
	7.—Ordinary frames to shell and floors; reverse bars; all bulkhead stiffeners; all keelson stringer bars; deck beams and deck plating; deck houses and all similar non-water-tight work	7½	4 3/16	4 11/16	5⅛	5⅝	6 9/16	7½	8 7/16
Spacing of rivets. Oil tanks only.	1.—Single riveting of laps and angles for oil-tight work	3	1 11/16	1⅞	2 1/16	2¼	2⅝	3	3⅜
	2.—Double chain riveting	3¼	1 13/16	2	2¼	2 7/16	2 13/16	3¼	3⅝
	3.—Double zigzag riveting for oil-tight work. Each row	4	2¼	2½	2¾	3	3½	4	4½
	4.—Middle line keelson angle bars; clips connecting the side stringers and keelsons to the shell plating. Single riveted	3¾	2⅛	2 5/16	2 9/16	2 13/16	3¼	3¾	4 3/16
	Double and zigzagged.	4¼	2⅜	2 10/16	2 15/16	3 3/16	3 11/16	4¼	4¾
	5.—All bracket plates; beam knees; non-water-tight clips; clips not connected to the shell plating. Single riveted.	4	2¼	2½	2¾	3	3½	4	4½
	Double and zigzagged.	5	2 13/16	3⅛	3 7/16	3¾	4⅜	5	5⅝
	6.—Ordinary frames to shell plating; reverse bars to floors and frames; deck plating to beams; bulkhead and expansion tank stiffeners when not caulked; keelson and stringer running angles when not caulked; web plates to the frames; deep frames to frames. Single riveted.	6	3⅜	3¾	4⅛	4½	5¼	6	6¾
	Double and zigzagged.	7½	4 3/16	4 11/16	5⅛	5⅝	6 9/16	7½	8 7/16

ENGINEERING SPECIALTIES.

Lawrence Two-Cycle Marine Engine.

Designed for a maximum of simplicity, this engine is built in three sizes, 1 1-2, 3 and 5 horsepower, and operates at respectively 450, 450 and 425 revolutions per minute. The general construction is well shown by the illustration. It may be said in



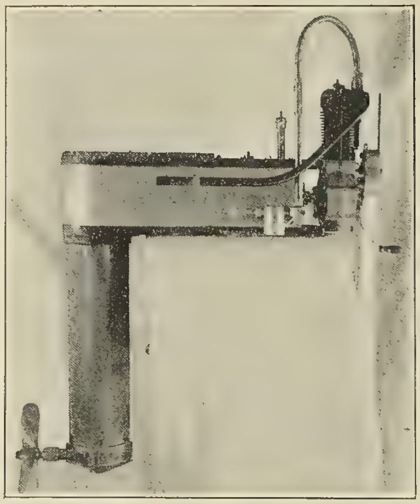
general, however, that the crank shaft may be readily removed without disconnecting anything but the connecting rods, and that all wearing parts are provided with simple and ready means of taking up wear and to avoid disturbance through wear of the alignment of the working parts. The engine is built by the Lawrence Machine Company, Lawrence, Mass.

The Raabe Motor for Boats.

The box-shaped frame contains the gasoline tank, as well as the battery and spark coil. To the inboard end of the frame the motor is attached, while the other end carries the elliptical column, with the propeller at its lower end. The motor shaft and propeller shaft are connected by means of a sprocket chain of fine pitch, making the transmission very efficient and noiseless.

The propeller shaft is made of phosphor bronze with extra long bearings, and is supplied with a ball thrust bearing of hardened tool steel, the sprocket and chain being also made of hardened tool steel. The lower sprocket as well as the thrust bearing and propeller shaft bearing run submerged in oil and graphite, and as the chain constantly carries an amount of oil and graphite upwards, the upper sprocket and its bearings are also constantly lubricated.

Leakage is prevented by means of a stuffing box of extra depth, and the stuffing-box gland is prevented from turning by a jam nut. The carburetter is of the constant level type of novel design supplied with a needle valve which admits very fine adjustment. The starting crank is at the inboard end of the motor and does not revolve when the engine is running.

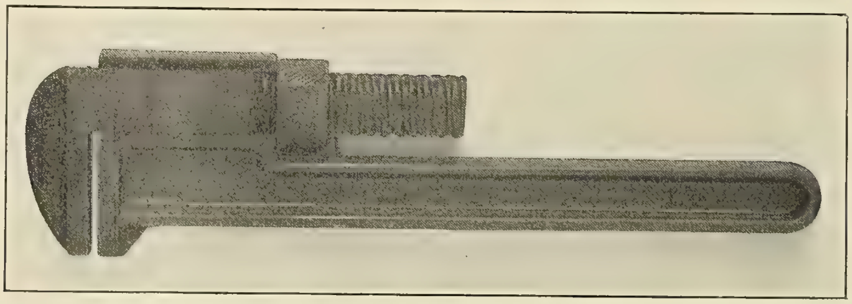


The entire two-horsepower outfit illustrated weighs only 50 pounds, and will contain enough fuel to supply the engine for ten hours' steady running; an additional storage may be kept in an oil can in the boat. On account of the light weight, this machine is extremely well suited as auxiliary power for sailboats, but any rowboat can easily be converted into a launch by setting this machine into the stern.

All parts coming in contact with the water are made of phosphor bronze, the frame being made of steel heavily galvanized, and the crank case of aluminum; the only cast-iron part is the motor cylinder.

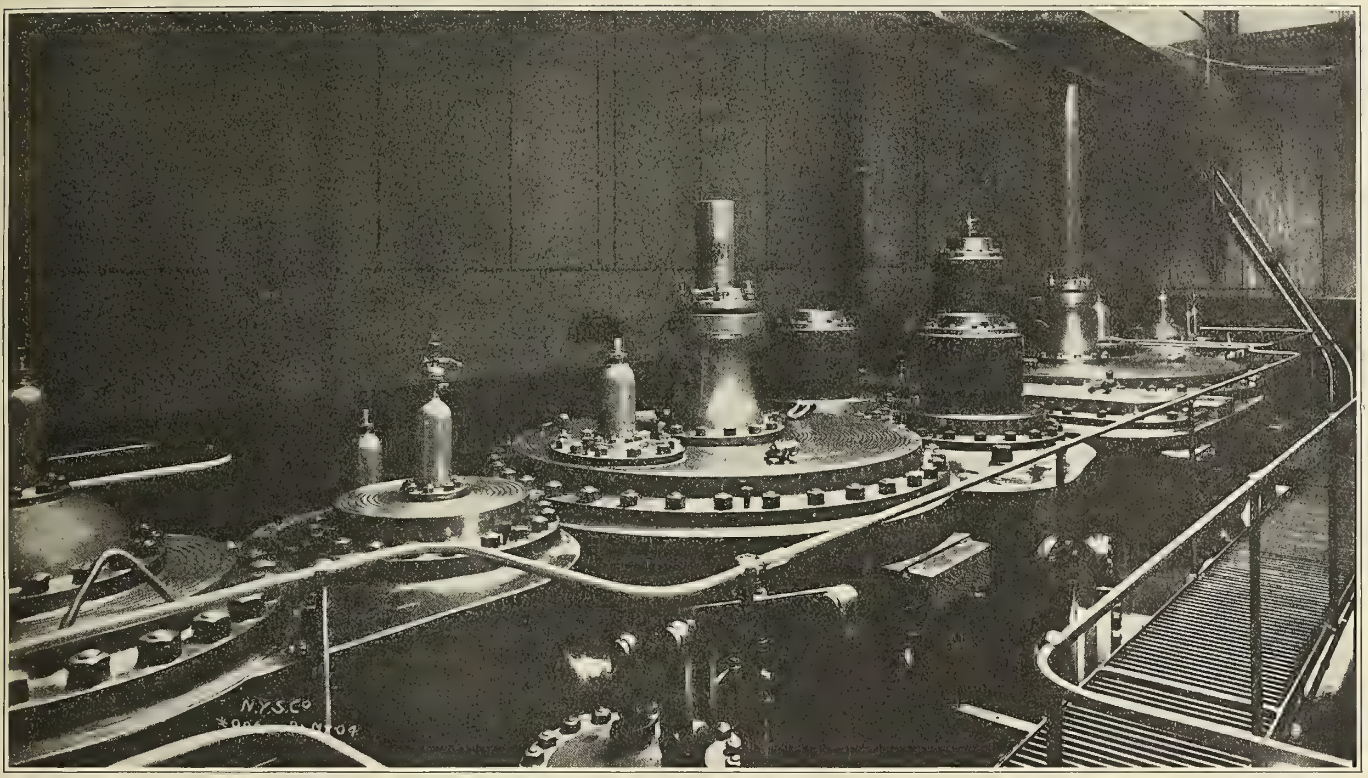
The Trimo Wrench.

Made of three parts, all of which are of forged steel and case hardened, this wrench is constructed for strength and hard usage. The threads of the jaw and of the nut are rounded like the Whitworth thread, rendering them impervious to bruises or other causes to interfere with their proper working. In direct contrast with the usual monkey-wrench, this wrench, as will be seen from the illustration, increases its leverage with increasing size of nut, as the jaw is extended forward instead of drawn back. The wrench is made in three sizes, 10-, 12-, and 15-inch, and is placed upon the market by the Trimo Manufacturing Company, of Roxbury, Mass.



Balance Cylinders.

The purpose of a balance cylinder is to neutralize the forces set up by a reciprocating body. It should be so designed that these forces meet equal and opposite forces in the balance cylinder instead of transmitting them in the shape of pressure to the crank shaft or whatever other device is used to impart the reciprocating

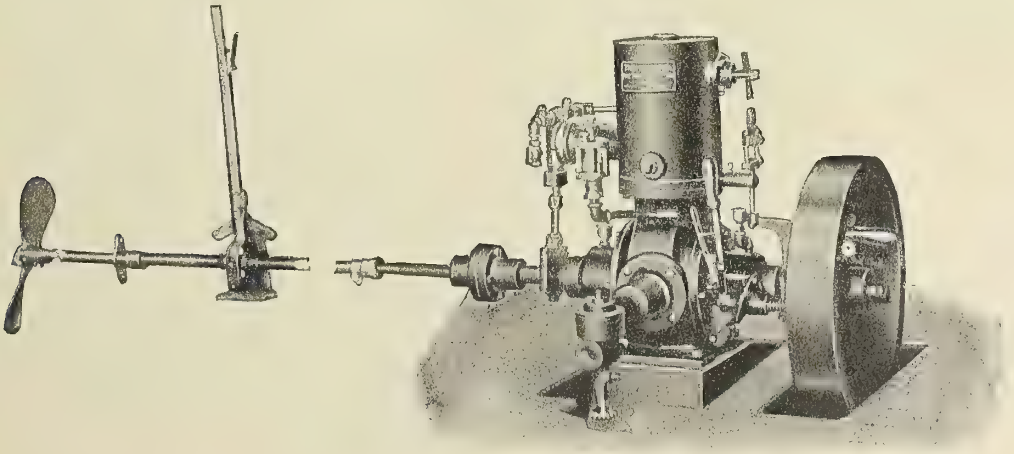


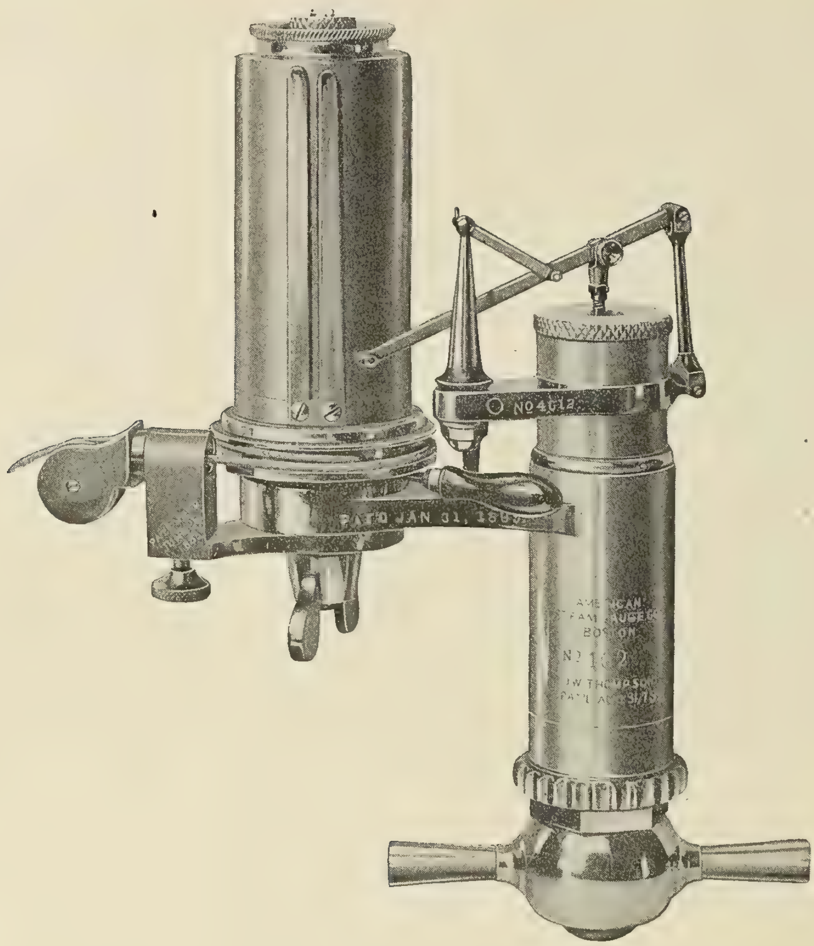
motion. This is a subject which has hitherto received little attention from scientific designers; in fact, the only field to which these cylinders have been applied is that of valve gears, and in this it has been done so crudely that the cylinders are really not balance cylinders at all, for they neglect the most important force developed by the reciprocating body. An exception to this is the Lovekin-Thom assistant cylinder, the theory of which was first set forth in a paper read before the Society of Naval Architects and Marine Engineers in November, 1902.

The function of a true balance cylinder is to act as a spring or dashpot at the end of each stroke. The energy expended in compression is returned in expansion, so that theoretically the reciprocating motion could continue indefinitely and without the consumption of steam or other outside source of power. This theory has been applied by the New York Shipbuilding Company to the low-pressure cylinders on the steamship *Manchuria,* which was recently put into service on the Pacific. The actual results as taken from indicator cards show that practice approaches very nearly to the theoretical conditions. We present reproduction of a photograph showing the upper part of the engine room of the *Manchuria,* with assistant cylinders in place.

The Wizard Marine Gasoline Engine.

We present an illustration of the Wizard engine and propeller, which is stated to be ideally adapted to marine use. Equipped with a patent speed changing device, the rate of rotation may be very quickly changed to anything between 200 and 1,200 revolutions per minute without the necessity of changing the position of the spark or the mixture of the gas. This enables the power of the motor to be varied from 1 to 6 horsepower. A governor is fitted, which, in connection with the changing device, will automatically maintain within the limits of the stated power any required rate of speed. A reversing clutch is fitted, which obviates the necessity of reversing the blades of the propeller, and thus conduces to increased efficiency in the latter. The weight of the engine is about 225 pounds. The propeller is of the three-blade pattern with a diameter of 14 inches. The engine is adapted to launches up to a length of about 22 feet. It is manufactured by the Temple Pump Company, of Chicago.





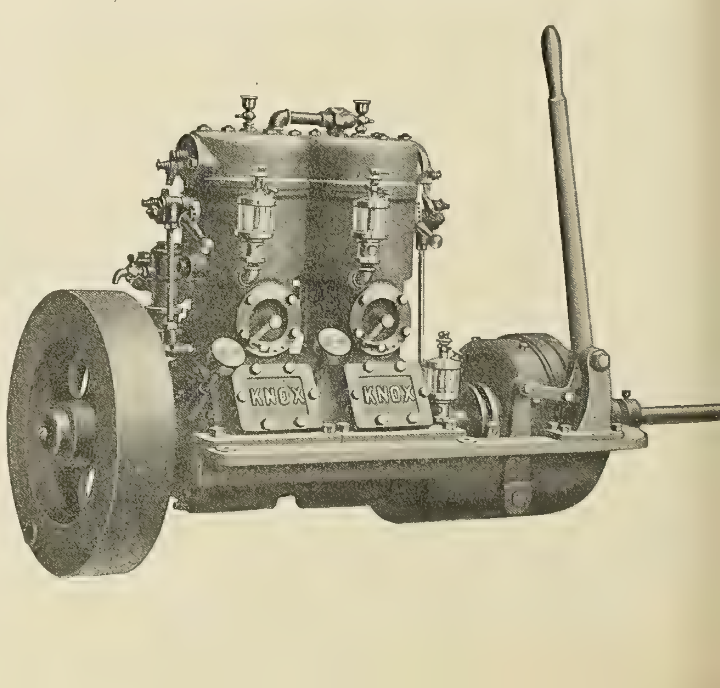
Indicator for Gas Engines.

In order to meet the requirements in adaptability to high speed and high pressures imposed by gas engine practice, the American Steam Gauge and Valve Manufacturing Company, of Boston, have brought out the modification of their Thompson indicator shown in the accompanying engraving. The piston is reduced to one-quarter inch area, which doubles the capacity of the spring and makes the working of the instrument more steady under the high pressures and sudden shock to which it is subjected in this class of work. When desired, a piston one-eighth of an inch in area is furnished in connection with this instrument. This adapts the instrument to the exceptionally high pressures met with in gas engine practice. A special mixture of metal is used for the cylinders, with a view to obtaining an even movement of metal under the severe ranges of temperature and strain.

The diagram reproduced herewith was taken with one of these indicators with a 1-8-inch piston, with a spring which scales 150 when used with a 1-2-inch piston, but which with the smaller piston scales 600. The pressure was about 600 pounds and the speed 230 revolutions per minute. The diameter of the paper barrel is reduced to 1 1-2 inches and it is provided with a specially strong spring, diminishing the difficulties of keeping its motion synchronous with that of the piston. It is provided with the detent motion described in our February issue, which finds a particular application in this field, where the speeds are usually so high as to make it difficult to hook and unhook the cord. The instrument is furnished without the detent motion, when desired, and in that form has been successfully used on recent tests at 975 revolutions per minute. The parallel motion and the working parts are also made as heavy as is consistent with accurate operation.

The Knox Marine Motor.

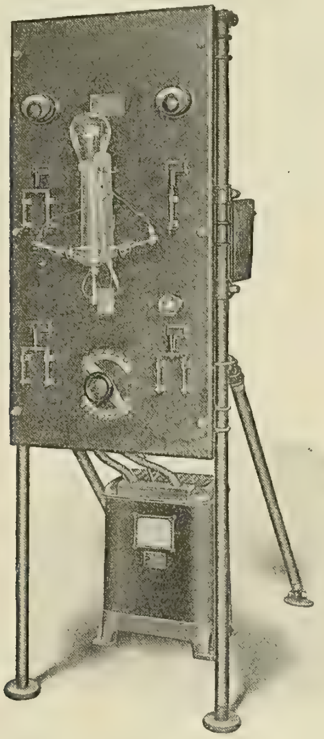
This motor is put on the market by the Camden Anchor-Rockland Machine Company, of Rockland, Me., and is of the two-cycle type, with the piston acting as a check valve, and the engine taking gas from the carburettor through a port hole in the cylinder under the exhaust port, which port hole is closed and opened by the piston on every stroke. The igniter is a plug easily removable and having adjustable firing points of the make-and-break pattern. The crank pin is oiled from a cup located on the outside of the cylinder, no oil being carried in the crank chamber. The builders



have a large foundry connected with their plant where all of the iron and composition castings for this engine are made. The crank shafts are heavy and are drop forgings. The engines are built in the one-cylinder pattern from 1 1-2 to 6 1-2 horsepower, and the two-cylinder engines from 5 to 13 horsepower.

Mercury Arc Rectifier.

In the exhibit of the Electric Launch Company, at the recent Motor Boat and Sportsmen's Show, was shown one of the General Electric Company's mercury arc rectifiers in full operation. It was used to charge forty-four cells of battery in the electric launch *Rest Awhile,* the current being 30 amperes at 110 volts,



direct current; the alternating current used is 220 volts, 60 cycles. This presents an interesting field for the use of mercury arc rectifiers, and it is probable that the use of electric launches may be materially increased because of the simplicity of the charging outfit now offered.

PERSONAL.

Mr. William Griscom Coxe, for many years guarantee engineer for William Cramp & Sons' Ship and Engine Building Company, has been elected president of the Harlan & Hollingsworth Corporation, Wilmington, Del.

Mr. W. A. Stadelman, for several years New York representative of the Brown Hoisting Machinery Company, has accepted the position as New York representative for the Wellman, Seaver, Morgan Company.

Mr. Richard Devens, who for some years has been connected with the European office of the Brown Hoisting Machinery Company, has been appointed manager of the New York office, 26 Cortlandt street, New York, N. Y.

Capt. John W. Collins, Engineer-in-Chief of the Revenue Cutter Service, has been granted a year's sick leave, and Chief Engineer C. A. McAllister has been appointed Acting Engineer-in-Chief.

Robert R. Livingston, M.E., formerly with Allis-Chalmers in their Chicago office, has associated himself with W. S. Barstow, consulting engineer, at 56 Pine street, New York city.

TECHNICAL PUBLICATIONS.

The Steam Engine. Vol. 1, The Thermodynamics and the Mechanics of the Engine. By Robert C. H. Heck, M.E. Pages 391 + 66; figures 190. New York: D. Van Nostrand Company. Price $3.50 net.

The object of this book is to set forth clearly the fundamental principles of the steam engine, to give a broad description of constructive practice, to explain fully the working of the apparatus in its several component parts, and to show how to obtain and improve its efficiency in performance. Intended to be used as a textbook for the use of students, it is, at the same time, designed as a complete engineering treatise, to be followed in Vol. II by a discussion of the form, construction and working of the engine, as well as several chapters devoted to the steam turbine. All mechanical and physical deductions are built up from basic foundations in order to render the book as much as possible self-contained. Many examples are given to illustrate the principles involved, and some use has been made of the calculus to develop the theories; graphical methods are very generally used as being in many cases much easier of comprehension than algebraic.

On the side of thermodynamics the purpose has been to present only what is essential to the theory of the steam engine as a working apparatus. The primary theory of the operation of a steam engine with a perfect gas is first built up before going into the properties of steam as used in commercial work. The working theory of the steam jet is given considerable attention, as well as the principles involved in the flow of steam in pipes and in the injector. A development of the entropy temperature analysis completes this division of the subject. At the back of the book are a number of tables of the usual sort to be found in a work of this character, principal among which, of course, is a table of the properties of superheated steam. The work concludes with a short discussion on superheated steam.

Boiler-Room Chart. By George L. Fowler. Size 14 by 28 inches. New York: Norman W. Henley Publishing Company, 1905. Price 25 cents.

This is an education chart, showing in isometric perspective the mechanisms belonging in a modern boiler room. The equipment consists of water-tube boilers, ordinary grates and mechanical stokers, feed-water heaters and pumps. Various parts of the appliances are shown broken or removed so that the internal construction is fully illustrated. Each part is given a reference number and this with the corresponding name is given in a glossary printed at the sides. The chart, therefore, serves as a dictionary of the boiler room, the names of more than two hundred parts being given on the list.

The Art of Generating Gear Teeth. By Howard A. Coombs. Pages 129 + 10; figures 37. New York: D. Van Nostrand Company, 1904. Price 50 cents.

This little book consists of a series of articles reprinted from the *American Machinist,* in which they first appeared, and carry the subject from the general theory of tooth curves into a discussion of the formation of gear teeth by machinery, and finally end with a rather complete description of new devices for generating gear teeth, and of forms of teeth other than the usual epicycloidal and involute teeth. It forms one of the Van Nostrand Science Series, and ought to have a considerable value for those who have in charge the designing of gear teeth and of machinery for cutting them.

Time Chart of the World. New York: Spon & Chamberlain, 1905. Price 25 cents.

This consists of a chart with all the important cities of the world placed around it in positions corresponding with their respective longitudes, and is fitted with a rotating member containing the hours of the day. This permits the hour at any given place to be immediately learned by putting the corresponding hour at the place of the observer opposite his corresponding longitude.

Report of the Merchant Marine Commission. In three volumes. Washington: Government Printing Office, 1905.

These three volumes contain a total of 1,985 pages of testimony taken before the meetings of the Merchant Marine Commission last year, and include in full all the opinions rendered by the myriads of experts on the subject, whom the commission consulted in the course of its labors. The first eighty-two pages, which are not included in the total number mentioned, are devoted to the report presented by the majority, that presented by the minority, the bills proposed by both parties, and a two-page index to the same. The last one hundred and three pages of the third volume are devoted to a most exhaustive index of the entire work, with the splendid cross index to the same so frequently met with in government reports, and so convenient for purposes of reference. Just previous to this index appear statements by several gentlemen especially qualified to speak on the subjects, regarding the operation of steam turbines, and the general question of coal economy of ships of various speeds. These statements were submitted to the commission after the regular sessions had closed, but have been incorporated in the report as supplementary to the main body thereof. Considerable attention is given to the question of fitting turbines to ships which are designed to go at speeds of less than 15 or 16 knots, a procedure which has been up to the present date considered out of the line of economical operation, because of the fact that the necessary rotative speed of the turbines would operate to produce an excessive slip in the propeller.

The report, as a whole, is a monument to the extensive character of the investigation undertaken, and should be carefully examined by everyone interested in this very live topic.

Ferric and Heliographic Processes. By George E. Brown, F.I.C. Pages 149; figures 20. New York: Tennant & Ward, 1905. Price $1.00.

This is the second edition of this book. It deals to a considerable extent with the making of blue and other prints by the various processes, and contains a number of formulæ for making printing papers of not only the blue-print type, but of brown and black lines on white grounds, together with samples of the papers as made. For the use of photographers and in drafting offices the book should be decidedly valuable.

A Class Book of Naval Architecture. By W. J. Lovett, Lecturer on Naval Architecture at Belfast Municipal Technical Institute. Pages 283 + 50; figures 173. New York and London: Longmans, Green & Company, 1905. Price 7/6 net.

This book is intended for class-room use, and represents the results of the experience of the author in his classes in the Municipal Technical Institute. The subject is taken up in the usual way, beginning with chapters on mathematics and the applications thereof, and running through the various ship calculations for displacement, center of buoyancy, stability, weight and stowage, trim, launching calculations, strength, etc., and this part of the work is followed by a chapter on laying off the lines in the mold loft, another giving a brief synopsis of the more important rules of Lloyd's Register, and of the British Corporation, and a further chapter regarding the actual construction of a ship, beginning with the preparation of the berth, the arrangement of the keel blocks and appliances, and the work necessary for the preparation of the various component elements of the ship and their incorporation in the structure. The last chapter is devoted to examination papers from the London Board of Education, together with useful tables of constants, logarithms, etc., and in the extreme rear of the book are a number of blank pages for notes and memoranda. While quite brief, it seems to cover a great deal of ground, and, when supplemented by the lectures with which it is doubtless designed to be associated, ought to be a splendid work on the general subject. Without these lectures it still forms an excellent work of reference.

A Text Book of Marine Engineering. By Engineer Commander A. E. Tompkins, of the Royal Navy. Pages 383 + 26; figures 266. Portsmouth: J. Griffin & Company; and New York: D. Van Nostrand Company, 1904. Price $6.00.

This is a comprehensive work on the subject indicated in the title, and starts with the usual definitions of the various component parts forming the machinery outfit of a ship, goes through the development of the design and operation of the various items involved, together with a discussion on the several types in vogue under each head, and ends with several chapters devoted to water-tube boilers, liquid fuel, and marine steam turbines. The book is the second edition of the work and has been considerably enlarged, and in part re-written, as compared with the first edition. A practical application of mathematics being essential to the design and economical working of marine machinery, use has been made of the principles of the calculus in bringing out some of the points touched upon; but, as the book is offered as a summary of the practice of the present day, and not so much a theoretical treatise, the reading matter has been made as simple as possible and the higher mathematics resorted to only where it was necessary to illustrate a point or develop a theory. One interesting feature of the book consists in the fact that all of the cuts are printed on insets on plate paper, which renders the work of considerably greater extent than is indicated by the mere enumeration of the number of pages.

The Steam Turbine. By Dr. A. Stodola, Professor at the Polytechnikum in Zurich; translated by Dr. Louis C. Loewenstein. Pages 434 + 66; figures 241. New York: D. Van Nostrand Company, 1905. Price $4.50 net.

This work was first published in 1903, as a serial in *Zeitschrift des Vereins Deutscher Ingenieure*, but has been very largely amplified before being published in book form. A considerable amount of important constructive details have been added, thanks to the assistance of many builders of the steam turbine; while much weight is given, of course, to the discussion of the scientific principles involved in this particular type of motor. The work is arranged in six sections, of which the first develops the elementary theory of the steam turbine by means of a discussion on adiabatic changes in the condition of steam and the flow of steam through nozzles. The second section discusses the theory of the steam turbine considered as a thermodynamic machine, and takes up the laws of energy as applied to the turbine. In the third section are given the details of construction of the more important parts of the machine, prominent among which are the blades and the methods of fastening the blades into the disks. The fourth section is devoted to a discussion of the various types of steam turbines, with considerable material on the De Laval, Seger, Riedler-Stumpf, Zoelly, Curtis, Rateau, Parsons, Schulz, Lindmark and Gelpke-Kugel turbines. This section concludes with a discussion of the marine steam turbine and a comparison between the steam turbine and the reciprocating engine. In Section 5 are taken up a number of problems connected with the theory and construction of the steam turbine, such as the automatic centering of the rotating member about its own center of gravity, the stresses in the disk wheels, the critical velocity of a shaft of varying diameter, and the gyroscopic action of a marine turbine. The sixth section is called an appendix, and is devoted to "The Future of the Steam Engine." It is a mathematical and theoretical discussion of the second law of thermodynamics, entropy, and the economy of the steam engine, together with some remarks on the gas turbine.

As might be readily expected in a book of German production, free use has been made of higher mathematics and algebraic demonstration. The cuts are very clear and seem to be splendidly adapted to the purpose in hand. In a pocket attached to the back cover are a number of entropy diagrams. The book as a whole should be of great use to designers and engineers interested in the development of the steam turbine, as well as to students in engineering colleges who are interested in the subject.

QUERIES AND ANSWERS.

Q.—280. The answer given to this question in the April issue has provoked considerable comment, due to the fact that, although there are no ferryboats operating from one side to the other on the East River, in which the paddles may be revolved in opposite directions, there is a boat, the *Maryland,* which takes the Colonial Express through the East River from Harlem to Jersey City, and in which the propellers are fitted as above mentioned.

There is also a ferryboat on the Piscataqua which is similarly fitted. A large ferryboat in operation in San Francisco harbor is also so arranged that the paddlewheels may be rotated in opposite directions. We presume that there may be a few other scattered examples, but they are quite rare.

Q. 274.—Would you kindly inform me, through your Q. & A. column, how to figure out the displacement, curve of buoyancy, and stability of a modern design of yacht?

I have tried Simpson's rules but they don't seem to work, as each waterline is so much shorter or longer than the one above or below it, hence the spacing of the ordinates for calculation on a displacement sheet seems impossible. A. H. S.

A.—The article beginning on page 198 will fully answer the above query.

Q. 283.—I want to put a gasoline engine in a flat-bottom fish-boat, 34 feet long, 10 feet wide; will draw about 16 inches loaded. The speed wanted is about 6 miles per hour.

(1) How many horsepower required in the engine?
(2) How many revolutions?
(3) How big a wheel?
(4) What pitch?
(5) Single or double cylinder?

J. F.

A.—The data does not give us the displacement of this boat, but assuming from the general conditions of the case that the model is quite full, we have taken the block coefficient as .7, which gives a total displacement of 9.08 gross tons, or 20,320 pounds.

(1) The horsepower is found from the formula:

$$H = \frac{D^{\frac{2}{3}} V^3}{K} = \frac{4.35 \times 216}{160} = 5.88.$$

We have assumed the Admiralty coefficient as 160, and thus obtain the horsepower given, which may be roughly placed at 6.

(2, 3, 4) These three questions are so interrelated that it is best to work them out together. With this end in view, we have computed the size of propeller and revolutions in accordance with the formulæ given on page 115 of Marine Engineering for March. We have taken the slip-ratio as 25 percent, which gives factor $b = .82$. The fact that the Admiralty coefficient is taken as 160 gives us factor $a = 1.23$. The pitch-ratio has been assumed as 1.1, which gives factor c as .90, and we have assumed that the propeller is of a standard pattern, so that factor e will be unity. On this basis:

$$d = .9 \times 1.23 \times 82 \times .90 \times 1 \times \sqrt[3]{20,320} = 22.3,$$

which we will call 22 1-4 inches. The pitch will be 1.1 times this figure, or 24.5 inches, which equals 2.04 feet. The number of revolutions will be:

$$\frac{6 \times 88}{2.04 \times .75} = 345.$$

(5) As marine gasoline engines are now built, an engine of 6 horsepower would probably call for a single cylinder only.

Q. 281.—Will you please inform me what relation or proportion the air-pump cylinder volume has to the (H. P. or) L. P. cylinder volumes in *modern* compound-, triple-, and quadruple-expansion marine engines? Is this relation different for direct-connected, independent, single-acting, vertical-beam, and the later double-acting, "suction-valveless" or feather-weight types? Also, what is the ratio of the air-pump displacement to the feed-water volume for these various types. X. Y. Z.

A.—There is probably no item of marine design in which there is so much variation as in the relation of the size of an air pump to either indicated horsepower or size of low-pressure cylinder. For vertical single-acting pumps used in connection with compound, triple-expansion and quadruple-expansion engines the displacement volume per minute is found on the average to be about .2 cubic foot per I. H. P. Thus, for a 1,000-horsepower engine the displacement volume per minute should be about 200 cubic feet. Then, if single-acting, and making 100 double or 50 effective strokes per minute, the volume for one stroke should be 200 ÷ 50 = 4 cubic feet. For double this speed, or 100 effective strokes, the volume should be 2 cubic feet. While this figure represents an average, actual practice varies over a wide range, general experience showing that a much smaller pump if in good condition will maintain a good vacuum, but will require a longer time in which to develop it. The ratio may thus vary from as little as .06 cubic foot per I. H. P. to .25 cubic foot.

If, on the other hand, we refer the size of the pump chamber to the low-pressure cylinder, we find that this relation has no meaning unless the relative number of strokes is also taken into account. If the pump is attached, the number is the same, and we have one effective stroke per revolution. On this assumption the volume of the pump may be taken from about 1-18 to about 1-30 of the volume of the low-pressure cylinder. One-twentieth to 1-25 will give values agreeing fairly well with good average practice.

With the modern high-speed double-acting suction valveless type of air pump the total displacement volume per minute must still remain about the same. Each stroke is effective, however, and without the foot-valves the pump may be run much faster than with foot-valves as in the usual type. Due to these facts the actual displacement volume for one stroke may be made relatively much less than with the usual type of pump. Definite values will result as soon as the total displacement per minute and the number of effective strokes per minute are decided on.

Q. 284.—Please answer the following questions through Marine Engineering.

(1.) What is the difference in form of the go-ahead and backing sides of a screw propeller, and why?

(2.) Why are slide valves used on some cylinders and not on others of the same engine? L. M.

A.—(1.) In the general forms of screw propellers the go-ahead side or face of the propeller blade approximates in character to the surface of the true screw, while the backing side is convex in character, due to fact that the forces acting on the propeller require a certain amount of material for the requisite strength, and this material is placed upon the back of the blade.

(2.) The reason for the use of slide valves on the low-pressure cylinders of engines using piston valves on the other cylinders, is largely a question of design, and is mainly concerned with the problem of getting the engine within a definite and restricted space. The piston valves used on the high-pressure cylinders are considerably better in operation than the ordinary D slide valves, particularly with high-pressures, and where the question of space is not a paramount consideration they are often adopted on the low-pressure cylinders as well, but the more usual arrangement is to fit a slide valve on the large cylinders.

Q. 285.—Please answer in your next issue the following questions:

What amount of cooling surface is required per horsepower for outboard keel condenser; temperature of water 65 degrees? This is for a compound engine. Do you figure horsepower for condenser from high-pressure cylinder or from both? E. McC.

A.—The cooling surface for a condenser is figured rather from the steam consumption of the engine than from either the high-pressure or the low-pressure cylinder, or both. In practice, however, it is quite usual to figure the surface directly from the horsepower of the engine, assuming the latter to be obtained on a consumption of steam which does not differ greatly with different engines. The usual allowance for a marine engine of considerable size operating with a vacuum of 20 inches of mercury is 1 1-4 square feet of cooling surface per horsepower. Another way of getting at it is to make an allowance of 1 square foot of cooling surface for every 20 pounds of steam condensed in one hour. This takes note of the varying efficiencies of different engines and is much the more accurate method. As the engine in question, operating with a keel condenser, is probably quite small, we may assume the steam consumption to be in the neighborhood of 30 pounds per horsepower per hour, in which case the condenser surface should be 1 1-2 pounds for each horsepower of the engine.

Q. 286.—The engines of a ship develop a certain I. H. P. in slack water. With the same M. E. P. will the I. H. P. be increased if the ship is running with a favorable current, and diminished with an opposing current? C. F. H.

A.—With a given M. E. P. the I. H. P. of an engine is directly proportional to the R. P. M. The R. P. M. obtained from the engine will not be affected by the current in which the ship is floating; because of the fact that with a given R. P. M. the ship's speed, *with relation to the water in which she floats,* will be constant. The speed of the ship, with regard to points on shore, will not be the same under the varying conditions of current and slack water, but this fact will not affect either the R. P. M. or the I. H. P.

Q. 287.—Charles H. Cramp said at a meeting before the Society of Naval Architects in 1894 that a shaft could not have more than 10,000 H. P. applied to it. The *Deutschland* has 35,000; *Lucania,* 30,000; *Kaiser Wilhelm II,* 40,000, and many others. Did he mean that a 22-inch shaft could not stand more than 10,000 H. P.? The steamboat *Puritan* has only one crank with a H. P. of 7,500. Are there any rules for figuring out how many revolutions a wheel like the *Puritan's* should make to make 20 miles per hour? F. B.

A.—The fact that under ordinary circumstances it was considered desirable in 1894 to limit the amount of horsepower used on one shaft to 10,000, has not militated against the occasional use of more than that amount on certain express steamers in transatlantic service. It is a fact, however, that the three ships mentioned, having engines of respectively 35,000, 30,000, and 40,000 horsepower, have two shafts each, thus dividing by two the amount of the total power which is applied to each shaft.

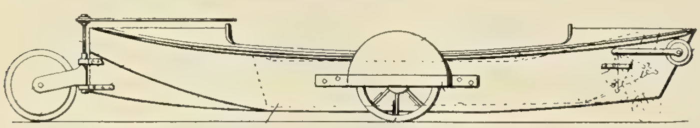
The number of revolutions required for a paddle wheel in a steamer making a given speed may be obtained from the formula:

$$R = \frac{88V}{\pi D\ (1 - s)}$$

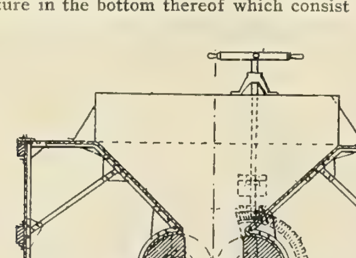
where V is the speed in miles per hour, D is the mean diameter of the paddle wheel to the middle of the blades, and s is the slip of the paddle. This value of s will vary usually from 15 to 20 percent.

SELECTED MARINE PATENTS.

780,835. SURF BOAT. BENJAMIN J. SUCH, WASHINGTON, D. C.
Claim.—4. The combination with a boat, combined paddle and traction wheels arranged at opposite sides of the boat, a motor for driving said wheels, and a combined steering wheel and rudder arranged at the stern of the boat, of a pair of wheels arranged at the bow of the boat on opposite sides thereof and adapted to project below the bottom of the boat, and means for raising said wheels above the water line. Nine claims.

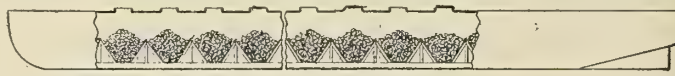


784,286. HOPPER BARGE. JAN VOLKER-TYSZOON, DORDRECHT, NETHERLANDS.
Claim.—2. In a hopper barge, devices for opening and closing the discharging aperture in the bottom thereof which consist of rotatable portions of circular segmental section placed and working in chambers inside the barge parallel to the longitudinal axis thereof, and means for turning the said portions on their axes into such a position that they bear against each other when the discharging aperture is closed, or into such a position as will leave the said aperture free and clear when the discharging aperture is opened. Three claims.



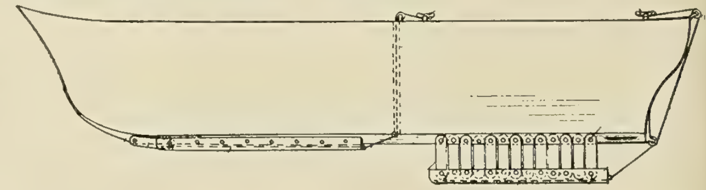
780,872. ENGINE FOR OPERATING CLAM-SHELL BUCKETS. JAMES G. DELANEY, NEWARK, N. J.
Claim.—8. An engine of the class described, having a drum for a bucket-hoisting cable, another drum for a bucket-operating cable, means for imparting traversing movement to the last-mentioned drum, means for locking the first drum at will, and means for insuring the simultaneous rotation of the drums when the traversing drum reaches the limit of the movement. Fourteen claims.

784,943. VESSEL FOR CARRYING ORE. FRANK K. HOOVER AND ARTHUR J. MASON, CHICAGO, ILL.
Claim.—5. In a boat of the character described, the combination with the outer shell or hull and a deck having hatchways formed therethrough, of a permanent inner bottom constructed to present alternate ridges and valleys extending across the vessel, the valleys lying directly beneath the hatchways and serving to contain the cargo, and the ridges lying between the hatchways and serving as internal bracing to strengthen the hull, substantially as described.

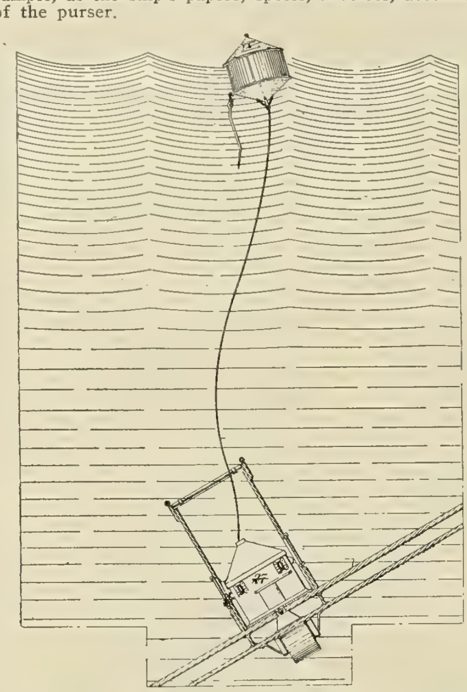


6. In a boat of the character described, the combination with the outer shell or hull and a deck having hatchways formed therethrough, of a water-ballast tank in said shell or hull having its top formed by a series of transverse ridges and valleys extending from side to side of the shell or hull, substantially as described. Six claims.

785,849. ADJUSTABLE KEEL FOR SHIPS OR BOATS. CHARLES ALBRECHT, CHICAGO, ILL.
This invention relates to an adjustable or drop keel which may be attached to the ordinary keel of a boat or to a false keel secured to the bottom of the boat, and which may be readily adjusted to project down into the water or folded up along the keel proper. One claim.



786,126. APPARATUS FOR MARKING SUNKEN VESSELS. FREDERICK W. JOHNSON, DAWSON, CAN., ASSIGNOR OF ONE-HALF TO JOHN P. PETERSON, DAWSON, CAN.
This invention relates to a means for marking sunken vessels and also for enabling the immediate recovery of the principal valuables on the ship—such, for example, as the ship's papers, specie, invoices, accounts, and other documents of the purser.



The apparatus comprises, broadly, a buoy which is connected with the vessel to rise to the surface as the vessel sinks. This buoy is connected with a box or vault in which is arranged a reel on which the line is wound, and the vault is also provided with compartments for the storage of the valuables of the ship. This box in turn is connected to the vessel by means of a line for which a second reel, permanently mounted on the vessel, is provided. Should the vessel sink, the buoy proper will immediately rise to the surface, and on doing so a ball therein will be released and the annular bell will be continually sounded. By hauling up on the buoy-line the vault or safe may be raised to the surface, and the position of the ship will yet be marked by the second line, which connects the vault with the hulk. Eight claims.

Marine Engineering

JUNE, 1905.

THE NEW STEAMSHIP BERMUDIAN.

One of the latest steamers to begin service from the port of New York is the twin-screw steel steamship *Bermudian,* belonging to the Quebec Steamship Company, Limited, and operating between New York and Bermuda. This handsome vessel, which we illustrate, was built late in 1904 by Sir James Laing & Sons, of Sunderland, England, and measures 5,530 tons gross. She has a length over all of 435 feet, a length between perpendiculars of 425 feet, a beam of 50 feet, while the depth is 36 feet 6 inches.

THE STEAMSHIP BERMUDIAN.

(Photograph by N. L. Stebbins, Boston.)

One notable feature in the arrangement is the promenade deck, which is 220 feet long and has a clear width without obstructions of 12 feet. This is shown in one of the illustrations. All of the boats are carried on the deck above this, and hence do not interfere in any way. There are 120 state rooms on three decks; those on the shelter deck being nearly all on the outside, and fitted with large windows which are at a sufficient height above the sea to be available for opening in almost any condition of weather. The state rooms on the saloon deck are both inside and outside, the former being lighted and ventilated by means of side ports in the deck-house above them, the deck being cut out in the wake of these lights. The dining saloon, of which we present a photograph, has 154 seats. It extends the entire width of the ship, and is lighted by a handome dome skylight running through the music room, which is also illustrated. The decorative scheme is very handsome, being of hand-carved panels, with ceiling and trimmings of white and gold.

A double bottom extending all the way forward and aft is provided for water ballast, and there is also a deep tank with a water-tight center division, which will contain 400 tons. The two tanks in the double bottom under the engine and boiler spaces have a center-line water-tight division, and are reserved for fresh water, which is used to feed the boilers. The dead-weight carrying capacity of the ship on a mean draft of 20 feet 6 inches is 1,800 tons, which includes 1,200 tons of cargo and 600 tons of coal in the bunkers. There are seven water-tight transverse bulkheads, dividing the ship into eight large water-tight compartments, besides those found in the double bottom. A bilge keel is fitted on each side in order to overcome as much as possible the natural rolling of the ship, and extends for a length of 160 feet. It is

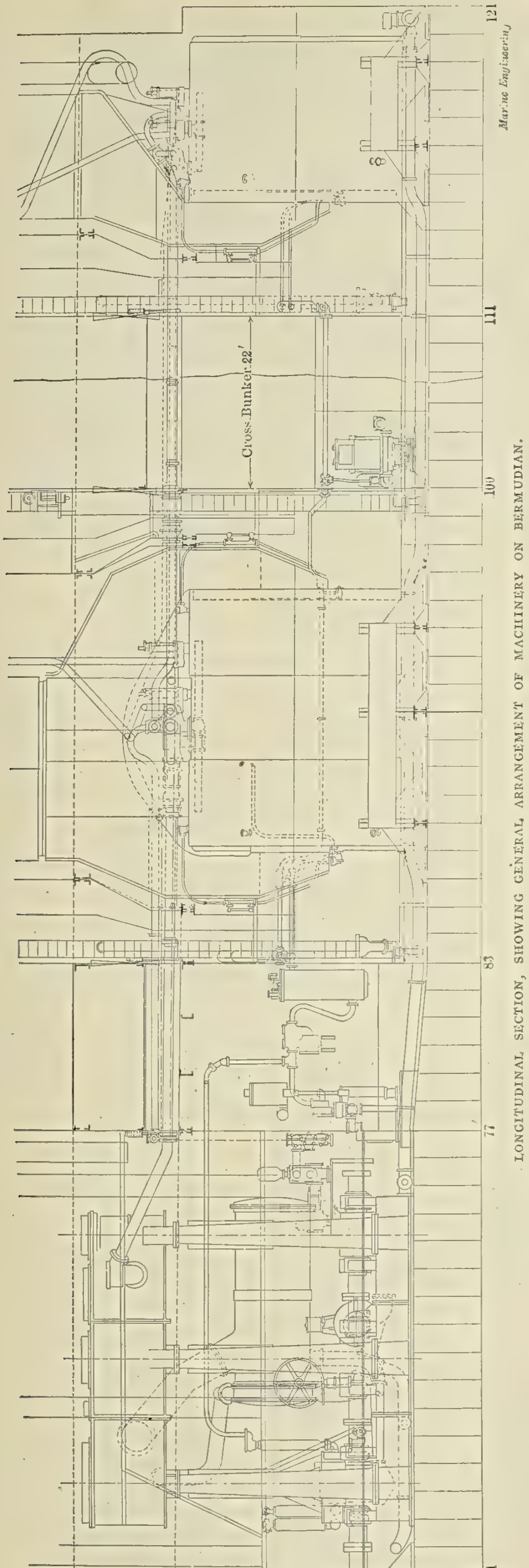
THE MUSIC ROOM ON THE BERMUDIAN.

made of a T-iron 6 by 4 by 1-2 inch with a bulb plate 10 1-2 inches wide and 1-2 inch thick riveted to it.

The machinery consists of two sets of triple-expansion engines having cylinders 26, 43, and 71 inches in diameter respectively, with a stroke of 48 inches, the steam being furnished by three double-ended and three single-ended boilers, working under a pressure of 200 pounds per square inch. The single-ended boilers have a length of 11 feet and a mean diameter of 14 feet 9 inches, while the double-ended boilers are 18 feet long with the same diameter as the others. Both forms are fitted with 3 1-4-inch tubes, and have a shell of a thickness of 1 3-8 inches of Siemens-Martin steel. The two funnels rise 96 feet above the grate bars. Each fire-room is fitted with Horace See ash ejectors, which discharge ashes about six inches above the mean water-line.

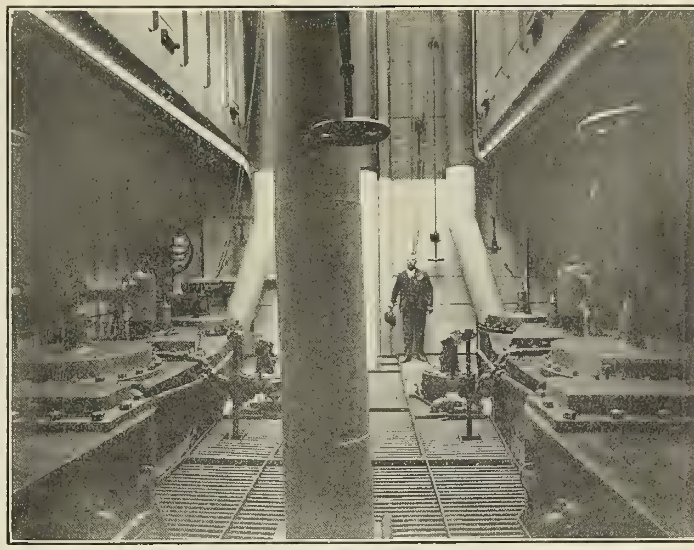
The crank shaft has a diameter of 14 3-4 inches, with bearings 17 1-2 inches in length. The crank pins measure 15 inches diameter by 17 inches long. The thrust shaft has the same diameter as the crank shaft, and contains eight thrust rings, with a total thrust area for each engine of 1,350 square inches. The propeller shaft has a diameter of 15 inches, and tapers at the rate of 1 inch

THE FIRST-CLASS DINING SALOON.



LONGITUDINAL SECTION, SHOWING GENERAL ARRANGEMENT OF MACHINERY ON BERMUDIAN.

per foot longitudinally where it enters the hub. The propellers measure 17 feet 6 inches in diameter, while the pitch-ratio of 1.23 gives a mean pitch of 21 feet 6 inches. They run at about 90 turns per minute, though on trial they were run up to 103. The requirements for the regular passage between New York and Bermuda



THE UPPER PART OF ENGINE ROOM.

call for 16 knots. On the full-power trial trip, which lasted forty-eight hours, the speed obtained with a little under 9,000 horsepower was 18.6 knots.

The entire ship is lighted by electricity and fitted throughout in the most modern manner. The American-De Forest Wireless Telegraph Company have installed their system of telegraphy on the vessel, and an operator dispatches and receives messages for passengers anywhere within 200 miles of Sandy Hook. It is noteworthy that messages sent from this ship when more than 200

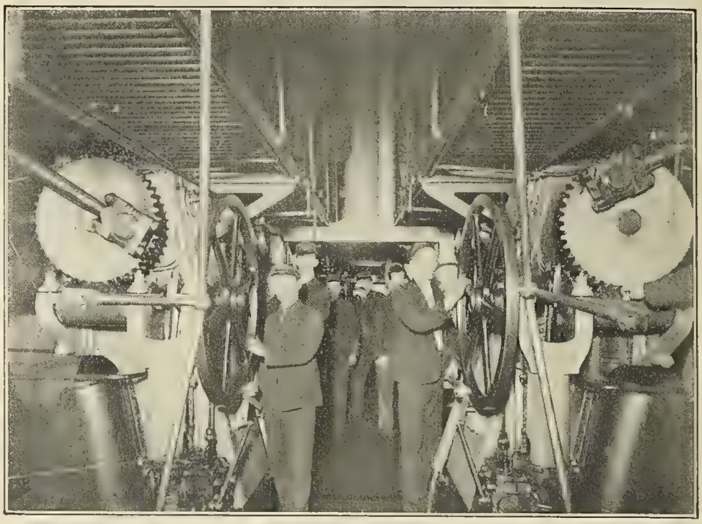
MARINE ENGINEERING DATA CARD. **JUNE, 1905.**

NAME—Bermudian. NATIONALITY—English. TYPE—Passenger and freight liner.
LAUNCHED—1904. BUILDER—Sir James Laing and Sons. OWNER—Quebec Steamship Co., Ltd.
BUILDER OF MACHINERY—Geo. Clark, Ltd., Sunderland.

Length over all	435 ft. 0 ins.
" between perpendiculars	425 " 0 "
Beam, molded	50 " 0 "
Depth, "	36 " 6 "
Load, draft	20 " 6 "
Deadweight cargo capacity	1,200 tons
Gross tonnage	5,530
Coal supply	600 tons
Speed at sea, designed	16 knots
" on trial	18.6 "
Propellers: Two; diameter	17 ft. 6 ins.
Pitch	21 " 6 "
" ratio	1.23
Funnels	2, rising 96 feet above grate

Engines: Type	3-cylinder, triple expansion
Cylinder diameters	26, 43, 71 ins.
Stroke	48 "
Indicated horsepower	8,500
Revolutions per minute	90
Shafting, diameter crank	14 3-4 ins.
" " propeller	15 "
Crank pins	15 ins. dia. × 17 ins. long
Condensing surface	8,650 sq. ft.
Boilers:	3 double-ended; 3 single-ended
Mean diameter, each	14 ft. 9 ins.
Length, d. e., 18 ft. 0 in., s. e.,	11 " 0 "
Working pressure	200 lbs. per sq. in.
Draft	natural

ON THE PROMENADE DECK.



THE STARTING PLATFORM.

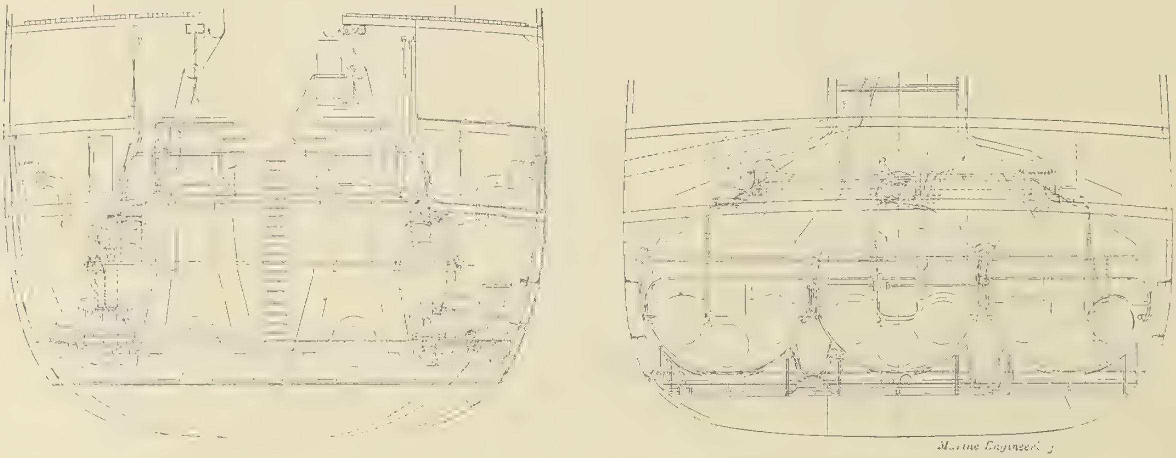
miles out from New York have been clearly read by the De Forest operator at Cleveland, Ohio, and signalled back to the New York office for corroboration.

There are two steam dynamos operated by compound engines and built by the Sunderland Forge and Engineering Company, of England, each of which operates at 300 revolutions per minute and is capable of carrying the entire load of five hundred 16 c. p. lamps. The rated output of the machines is 250 amperes at a pressure of 110 volts. The steering gear is from the works of Alley & MacLellan, of Glasgow. The main feed pumps, which are independent of the engines, are of the Weir type, with cylinders 14 and 10 1-2 inches in diameter and a common stroke of 26 inches. The main condensers, which are fitted well up in the wings, give a vacuum of 27 inches of mercury with a cooling surface each of 8,650 square feet. The refrigerating plant, with a capacity for cooling 15,000 cubic feet of space, has been fitted by J. & E. Hall, of Deptford, and operates on the carbon-dioxide principle. The insulated space actually fitted for service from this machine is only 6,000 cubic feet. The cargo winches fitted on deck are four in number, of friction type, having each two cylinders 8 inches by 10 inches, and were furnished by Williamson Brothers, of Philadelphia. In addition to these there is a large warping winch fitted just forward of the steering-gear house, with cylinders 8 inches by 12 inches, and furnished by Clarke, Chapman & Company, of Newcastle, England.

The ship was built and equipped under the supervision of Mr. P. Baldwin, the company's superintendent. The machinery and boilers were constructed by George Clark, Limited, Sunderland, to specifications prepared by Mr. Henry Black, superintending engineer of the Quebec Steamship Company, under whose inspection they were installed and tested. The vessel is classed 100 A1 in Lloyd's Register of Shipping. The passenger accommodations will take care of 240 first-class, 32 second-class, and 48 third-class passengers. Nearly all of this accommodation is on the upper decks in the vicinity of the music room, social hall, and smoking room.

The *Bermudian* sailed for Bermuda on her maiden trip on the 7th of January. Our photographs were all taken by Mr. N. L. Stebbins, of Boston.

Oil as Fuel on a Battleship.—The four after boilers of the British battleship *Prince George,* now undergoing repairs at Portsmouth, are being fitted to burn either oil or coal, there being two sprays to each furnace for the distribution of the oil. Tanks will be constructed in the double bottom to take 400 tons of oil, auxiliary fuel, to be used in case of emergency, such as the coal having run short or steam being quickly required.



SECTIONS SHOWING INSTALLATION OF ENGINES AND BOILERS ON BERMUDIAN.

LAUNCH OF THE NEBRASKA, OCTOBER 7, 1904.

LAUNCHING OF THE UNITED STATES BATTLESHIP NEBRASKA.

On October 7, 1904, this ship was launched by the Moran Brothers Company, of Seattle, Washington, in whose yard she is now being completed. We are indebted to her builders for the information here given of the particulars of the launch, as well as for the accompanying illustrations. The view of ship alongside dock was taken March 29, 1905.

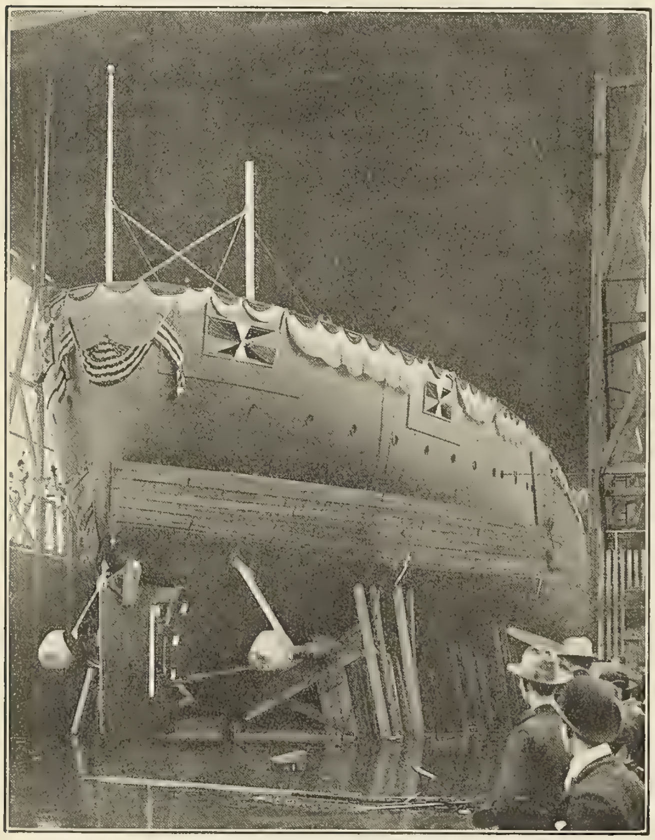
STATE OF COMPLETION.

At the time of launching the percentage of completion of all work pertaining to hull, ordnance, and equipment was 59.4, such percentage being based on the vessel completed under the contract requirements. The machinery on the same date was 79 percent completed. All structural work below the protective deck, except parts affected by recent changes, was completed, and nearly all similar work above the protective deck was in place and riveted. About two-thirds of all stanchions were in place. Openings for all doors were cut, and most of the doors fitted in place. All manholes to inner bottom were fitted and bolted down during the launch, except those in certain 6-inch magazines, where the inner bottom plating was pierced for work in connection with stowage of ammunition. All openings for outboard valves were cut and valves fitted, including main injections and outboard deliveries; openings for the hawse pipes were cut; opening for torpedo tubes not yet laid off. All outside hull work completed, rudder completed and in place; tail-shafts and hubs of propellers in place, zinc and fair-waters on. All deck plating fitted and riveted, lower part of main mast in, bitts and chocks in place, and many of the hatches completed; work on bridges not yet commenced. Main drain was completed and tested, and secondary and auxiliary drains about 90 percent completed. All generating sets, windlass and engine, were installed. Fresh and salt-water system work laid out on ship; fire main work laid out and piping in machinery spaces fitted; air ports in place. Interior casemate armor and the large tubes for the broadside turrets and the signal tube were completed. The broadside barbette armor was in place and the armored ammunition tubes on board. The transverse and longitudinal splinter bulkheads were all in place and almost completed. All wood backing for armor was fitted. A large part of the holes

CONDITION OF THE NEBRASKA, MARCH 29, 1905.

for various pipes in the ship were cut. Gun beds and foundations were about three-fourths completed. All compartments adjacent to the shell plating had been tested, the testing of the water-tight compartments as a whole being over one-half completed. The boilers were installed and up-takes fitted, the ice machine and evaporators, work-shop tools, and most of the auxiliary machinery being in place. In the shop the work was well along on the main engines and various machinery items, superposed turret foundations, masts, forgings for various gears, fittings for various systems, etc. Joiner work also in hand. The weight of the ship at the time of launching was 6,549.95 tons, which was subdivided as follows:

	Tons.
Structural work of hull	4,629.28
Armor	304.50
Splinter bulkheads	83.28
Protective deck, nickel steel	241.86
Wood	143.26
Paints, etc.	65.81
Hull auxiliaries (windlass, etc.)	28.73
Piping, valves, fittings, air ports, etc.	110.19
Equipment weights	52.72
Steam engineering weights	805.32
Miscellaneous dunnage and foreign weights (estimated)	85.00
Total	6,549.95



THE STERN BEFORE THE LAUNCH.

LUBRICANT.

The grease used was put on the ways September 18 and 19, 1904, and consisted of 1,950 pounds of tallow, 1,890 pounds of stearin, and 986 pounds of soap. The day before the launch the after ends of the ground ways were greased with 500 pounds of tallow and 450 pounds of stearin, making a total of 5,776 pounds of grease used in the launching. The first grease applied was pure stearin, then a mixture of stearin and tallow (60 and 40), and final coat of whale-oil soap. It was protected from dirt, etc., by light board strips on each side of ways. To take the weight off the grease the sliding and ground ways were separated by oak distance pieces 5-8 inch thick by 6 inches wide by 46 inches long, spaced about 10 feet apart. When the ship was launched there was no smoking of the ways, the lubricant was left almost intact, and almost 4,000 pounds were removed from ways the day after.

HYDRAULIC JACKS.

To assist in starting the ship one 100-ton hydraulic jack was located on the starboard ground way, and three smaller ones on the port ground way, these three totaling 110 tons. These jacks were butted against fir timbers that were securely bolted to the ground ways, the thrust of the jacks coming squarely against the head of the sliding ways. It was not necessary to use the jacks in starting the vessel. There being plenty of water, no attempt was made to stop the ship in any limited distance.

WEDGES.

During its construction the packing was supported by tapered pieces of fir 2 inches by 4 inches by 46 inches, which separated it from the sliding ways. On the day before the launching these pieces were replaced by fir wedges. These wedges under the poppets were 7 feet long and 9 inches wide, and under the solid packing were 6 inches wide, all being 6 inches thick tapering to 1-8 inch. Under the poppets, both sides, were 92 wedges, and under the solid packing, both sides, were 340 wedges.

The wedges were distributed as follows:

18 wedges 9 inches wide, each side, between frames 11 and 20.
80 wedges 6 inches wide, each side, between frames 20 and 50.
90 wedges 6 inches wide, each side, between frames 50 and 84.
28 wedges 9 inches wide, each side, between frames 84 and 98.
Total number, one side, 216; both sides, 432.

GROUND WAYS AND SLIDING WAYS.

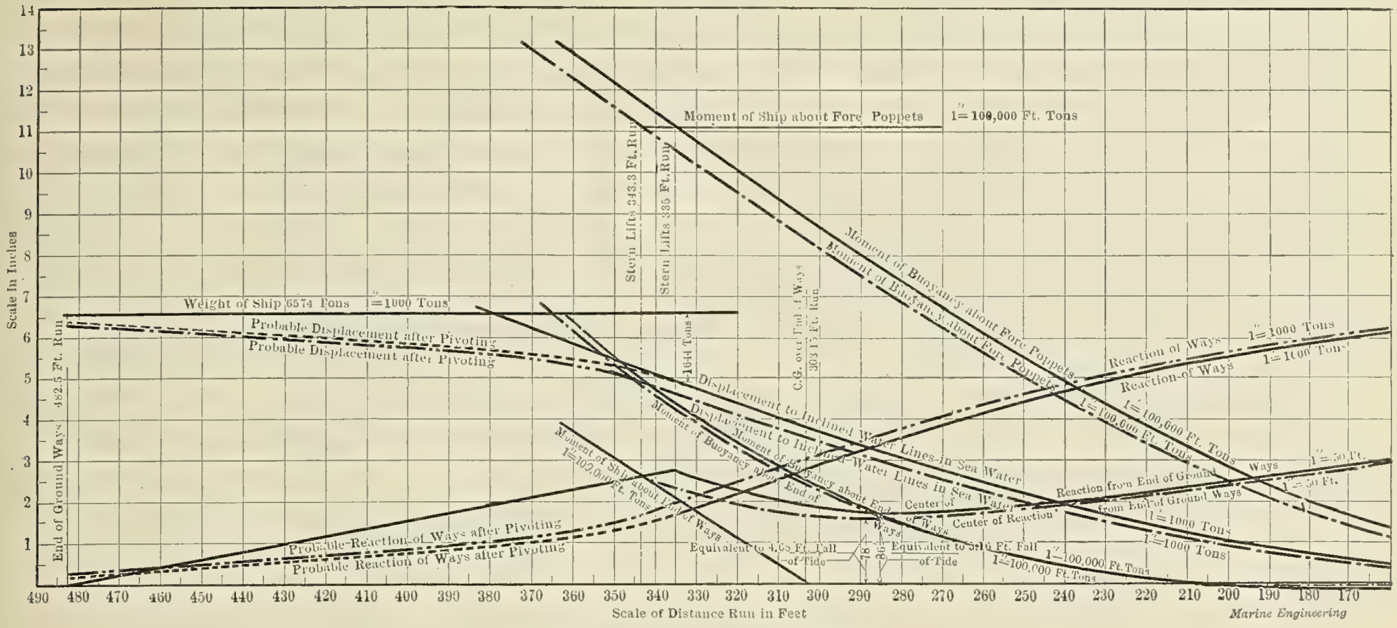
All parts of ground ways were exposed at low water. The total length of ground ways measured from sawing-off stations to ends of ways was 482 feet 6 inches, of which 172 feet 6 inches were under water. The spread of the ways measured between inner faces of the rib-bands was 30 feet 9 inches, the ways being parallel and the surfaces without transverse inclination. The ground ways were inclined 72-100 inch per foot throughout their length. These ways were supported by piles extending out to the ends, the transverse cap pieces being discontinued 16 feet from the end of the ground ways. The depth of water at end of ground ways was 9 feet 8 1-4 inches at time of launching, and 10 feet 4 inches for mean high water. The total length of sliding ways from sawing-off stations was 359 feet 6 inches. There were on each side eight poppets forward, extending from frame 11 to frame 19, and fourteen poppets aft extending from frame 84 to frame 98. The packing under forward poppets was separated from sliding ways by crushing pieces. In fitting the cradle care was taken that no pressure was brought on the laps of the plate ends. The after poppet was 30 feet forward of center of rudder pintles. The after ends of the ground ways for 178 feet were made in two thicknesses the upper part being 4 inches thick. These upper pieces were not fitted until a few days before the launch, thus preventing damage to under-water lubricant.

SOLE PIECES.

The sliding ways and ground ways were tied together at the head of the ways by means of 7-8-inch through-bolts, steel plates 7-16 inch thick top and bottom, acting as washers. Between the sliding ways and the ground ways a key of oak was inserted just forward of the saw cut. Just aft of the saw cut and between the same ways a 3-8-inch thick steel plate, 42 inches wide and 40 feet long, was securely fastened to the sliding ways to prevent freezing. The area of cross section of saw cut for one side was 420 square inches. The ship broke away when a little more than 1-4 of this area was left.

CONDITION OF THE SHORES BEFORE THE LAUNCH.

On October 6, 1904, the day before the launch, the ship was supported as follows: between the keel and ground ways and ex-



LAUNCHING CURVES FROM NEBRASKA.

tending from frame 12 to frame 89 there was a line of shores spaced four feet apart; fifteen feet outboard of ground ways there was a line of shores extending from frames 25 to 90 and spaced 4 feet apart; twenty-three feet outboard of ground ways there was a line of shores extending from frame 21 to frame 89 and spaced four feet apart. Total, one side, 213 shores; both sides, 426 shores. Besides the above-mentioned shoring, the ship was supported by cribbing under docking keels at frames 37, 43, 48, 56, and 70.

SHORING IN SHIP.

Over the line of the launching ways, extending from frame 11 to frame 18, the ship was shored as follows: on frames 11 and 12, port and starboard, and extending from second longitudinal to center of ship, there were two 8-inch by 8-inch diagonal shores; between frames 13 and 18, port and starboard, and extending from second longitudinal to lower platform, and between lower and upper platforms, there were lines of 8-inch by 8-inch shores. In each fire-room there were two 8-inch by 8-inch shores placed on blocking extending between second and third longitudinals, the shores being located between the boilers, all of which were in place.

MEASUREMENTS TAKEN BEFORE AND AFTER LAUNCHING TO DETERMINE HOG OR SAG.

For observing the hogging and sagging strains a transit instrument was located at frame 8, starboard side, and 10 feet 9 inches from center line, on a platform 4 feet high. At 105 3-4 starboard, a batten was erected on which was placed a target 13 feet above deck and 10 feet 9 inches from center line. Along either side of this line of sight three battens were located on which were read directly the deflections. Batten No. 1 was located on forward end of superstructure 10 feet from center line; batten No. 2 at frame 53, 10 feet 3 inches from center line; and batten No. 3 on after end of engine hatch coaming 11 feet 3 inches from center line. Just before any wedging-up had been done the scales on the three battens were set with zero in the line of sight. No appreciable deflection occurred until all the blocks and shores had been knocked out and the ship had settled on the ways, when the following readings were taken:

Batten No. 1 3-32 inch,
Batten No. 2 1-4 inch, } Sagging.
Batten No. 3 5-32 inch,

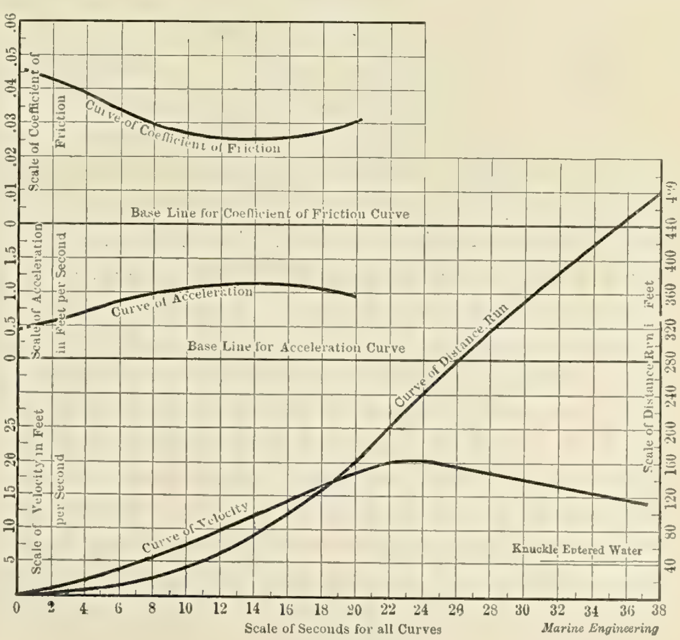
After the ship was launched the readings were as follows:

Batten No. 1 1-8 inch,
Batten No. 2 1-4 inch, } Hogging.
Batten No. 3 3-16 inch,

DIMENSIONS.

Length over all	441 ft. 3 ins.
Breadth (extreme)	76 ft. 2 1-2 ins.
Depth (keel to main deck at side), molded	41 ft. 4 1-2 ins.
Percentage of completion at launching	59.4

MEN EMPLOYED ON SHIP.		MEN EMPLOYED OFF SHIP.	
Caulkers	4	Ship carpenters	91
Fitters	4	Yard laborers	14
Riveters	2	Boat-yard laborers	22
Machinists	5	Ship-shed laborers	59
Plumbers	6	Electricians	2
Ship riggers	20	Repair Department	4
Government employees	5	Total	192
Total	46		



LAUNCHING CURVES.

LAUNCHING DATA.

Inclination of building slip per foot, 3-4 inch.
Inclination of ship per foot, 5-8 inch.
End of sliding ways below mean water level (measured along ways), 47 feet.
Length of sliding ways, 359 feet 6 inches.
Width of sliding ways, 3 feet 6 inches.
Thickness of sliding ways, 10 inches.
Area of sliding ways, square feet, both sides, 2,516.5.
Elevation of after knuckle above mean high water, 1.95 feet.
Launching weight of ship (weight record), 6,464.95 tons.
Launching weight, dunnage and shoring (estimated), 85 tons.
Weight of ship as launched (sum of above), 6,549.95 tons.
Launching cradle, including sliding ways (calculated), 169.25 tons.
Launching weight, total, 6,719.2 tons.

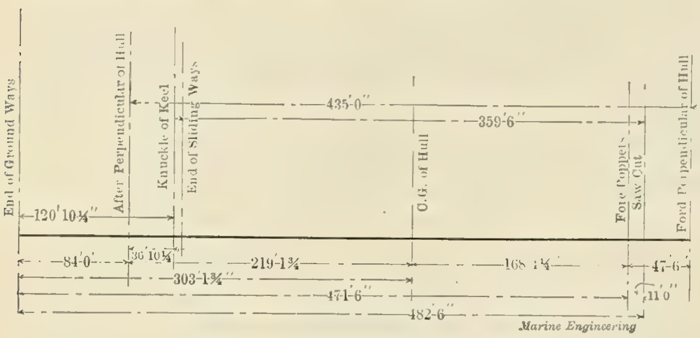


DIAGRAM OF DIMENSIONS OF WAYS.

Pressure on ways, tons per square foot, 2.67.
Draft forward, 11 feet 3 inches.
Draft aft, 12 feet 6 inches.
Mean launching draft, 11 feet 10 1-2 inches.
Corresponding displacement, water density 1.013, 6,515 tons.
Pressure on fore poppets at pivoting (calculated), 1,643.8 tons.
Time of starting to maximum velocity, 23 1-5 seconds.
Maximum velocity, feet per second (measured along ways), 20.25.
Maximum velocity, knots per hour (measured along ways), 11.99.
Distance traveled to maximum velocity (measured along ways), 224 feet.
Coefficient of friction, initial, .046.
Distance traveled to pivoting point (calculated), 335 feet.

THE TUG BOATS WM. E. CLEARY AND J. H. WILLIAMS.

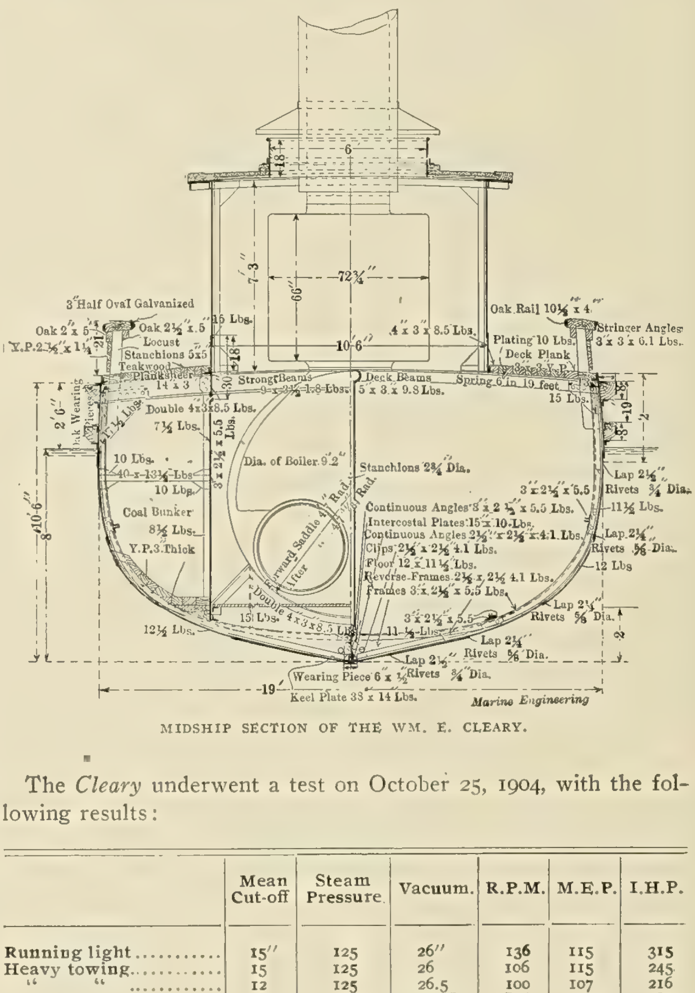
The tug boats *William E. Cleary* and *J. H. Williams*, owned and operated by the Cornell Steamboat Company, were designed by Mr. J. A. Hargan of this city, and built by T. S. Marvel of Newburg, N. Y. These tugs are built of steel, having a length between perpendiculars of 65 feet 6 inches, and a length over all of 75 feet. The molded beam is 19 feet and the depth at side 10 feet 6 inches. This gives a depth of hold of 8 feet 7 inches. The draft under ordinary conditions is 8 feet, but when carrying the full load, 15 tons of coal and 6 tons of water, the maximum draft aft becomes 9 feet 7 inches. The freeboard amidships is 2 feet 6 inches, the normal displacement 143 tons, while the net and gross tonnages are 61 and 87 tons respectively.

The hull is divided into five water-tight compartments separated by bulkheads located on frames 4, 8, 11 and 33. The frames consist of steel angles measuring 3 by 2 1-2 inches by 5.5 pounds, and are spaced 22 inches apart. The deck beams, which occur at every frame, are steel angles measuring 5 by 3 inches by 9.8 pounds. A flat plate keel is fitted 38 inches wide and 14 pounds in thickness. The stern post is of wrought iron 5 1-2 by 2 1-2 inches, and the stem, of the same material, is 5 1-2 by 1 1-2 inches. The shell plating, which is of steel, has a thickness of 11 1-2 pounds, except that the bilge strake is 12 pounds thick and the shear strake 13 1-2 pounds. The deck planking consists of yellow pine measuring 3 by 3 inches.

There is one condensing engine with a single cylinder having a diameter of 16 1-4 inches and a stroke of 20 inches. This engine develops 245 indicated horsepower when towing, and a maximum of 315 when running light. A piston valve is fitted and admission is cut off at 15 inches when in full gear. The pumps are of the Blake pattern and are all independent.

There is one boiler of the Scotch, single-end type, which has a length of 11 feet 6 inches and a mean diameter of 9 feet 2 inches. The average steam pressure to be carried is 125 pounds per square inch, and the expected gradient between boiler and engine is only one pound. The total heating surface in the boiler is 1,248 square feet, and the grate area is 48 square feet, giving a ratio of heating surface to grate area of 26 to 1. There are two furnaces of the Morison suspension type, having an inside diameter of 36 inches each. The maximum consumption of fuel is about 720 pounds per hour.

There is one cast iron propeller with a diameter of 7 feet and a pitch of 10 feet 6 inches, this giving a pitch-ratio of 145. The propeller is fitted with four blades of a maximum width of 37 inches, and is from the shops of T. S. Marvel.



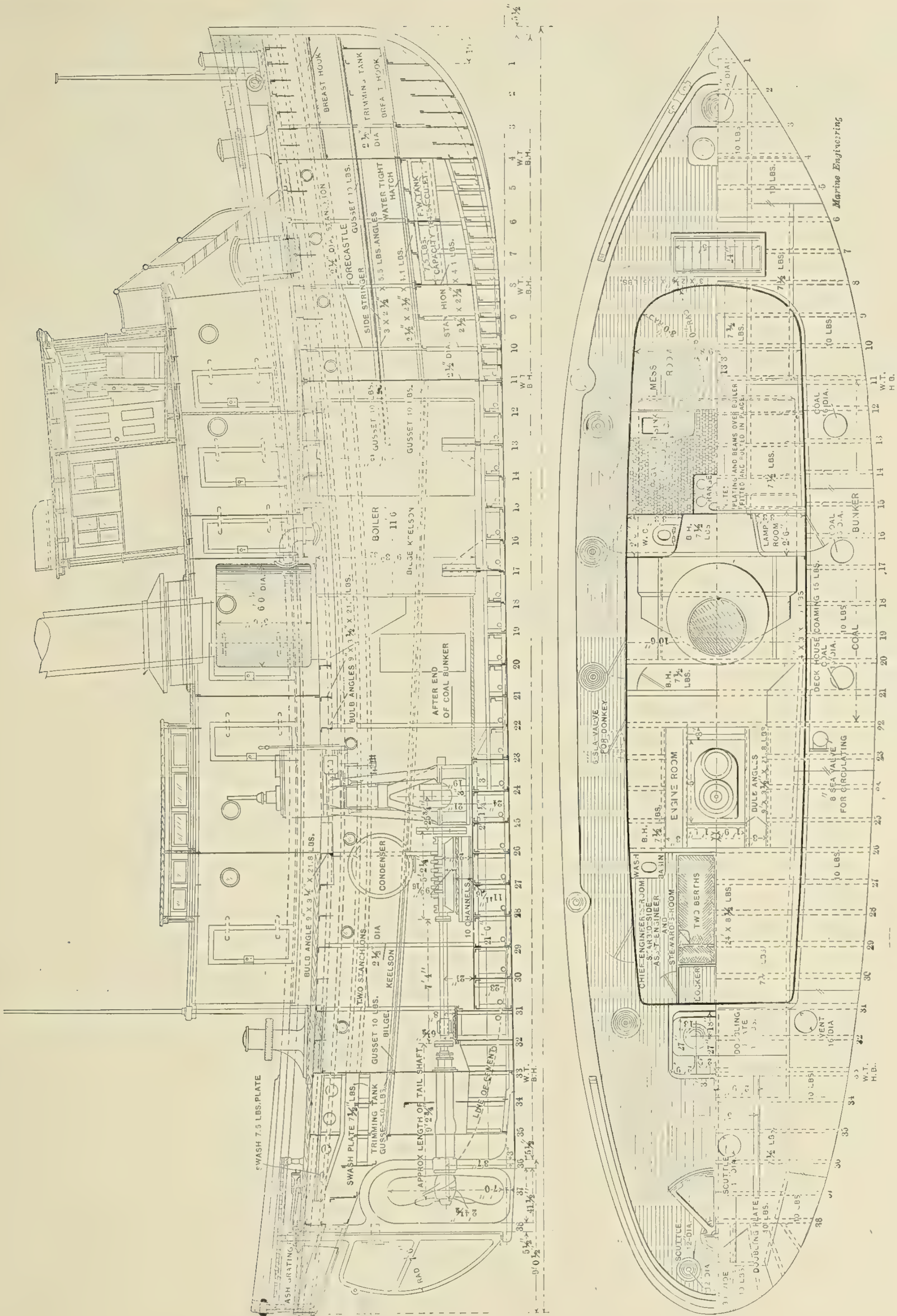
MIDSHIP SECTION OF THE WM. E. CLEARY.

The *Cleary* underwent a test on October 25, 1904, with the following results:

	Mean Cut-off	Steam Pressure	Vacuum.	R.P.M.	M.E.P.	I.H.P.
Running light...........	15"	125	26"	136	115	315
Heavy towing...........	15	125	26	106	115	245
" "	12	125	26.5	100	107	216
" "	10	125	27	96	97.5	189

When towing, the revolutions of the engine and propeller are 106; when running light 136. The speed in the latter case is 13 miles per hour. The boats cost $30,000 each, and the fuel capacity is 15 tons. The machinery was built by the Cornell Steamboat Company at Rondout, N. Y.

The Bureau of Navigation report that, during the quarter ending March 31, there were built in the United States 159 vessels of a total of 62,744 gross tons, of which 143 of 10,942 tons were of wood and 16 of 51,802 tons of steel. The steel ships were all



THE TUG BOATS WM. E. CLEARY AND J. H. WILLIAMS.

propelled by steam, while of the wooden ships 40 of 6,743 tons were propelled by sail and the balance by steam. The total compares with 177 vessels of 55,066 tons for the corresponding quarter of 1904. For nine months, ending March 31, 1904, there were built 748 vessels of 232,133 gross tons, or an average of 312 tons each; while during the corresponding nine months this year the total number built was 701, of an aggregate of 155,342 tons, or an average of 221 tons each. It is thus seen that not only is the total amount built during the nine months a smaller quantity than it was last year, but the vessels are of a considerably smaller size, and, therefore, the tonnage represents a much smaller effective addition to our shipping.

AMSLER'S MECHANICAL INTEGRATORS.

BY CECIL H. PEABODY.

Several years ago a series of articles was printed in Marine Engineering,* giving a simple geometrical explanation of Amsler's polar planimeter and some other forms of planimeters; the writer now desires to extend the method to the explanation of Amsler's integrator for determining moments, and moments of inertia of plane figures, with the hope that it will be possible to give a good conception of this instrument, which is now so widely used, to any who may find some confusion of thought in explanations that combine the statement of the mechanical construction of the instrument with an integration in the conventional form of the infinitesimal calculus. It is true that the idea of integration must ultimately be introduced, but it may be reserved until the construction and manner of use of the instrument is mastered, and that idea may be so presented that it is comparatively easy of comprehension. It is true, also, that a proper conception of the moment and moment of inertia of a plane figure requires a conception of integration, but that conception does not for our present purpose demand a knowledge of the notation and contrivances of the infinitesimal calculus. The mathematical forms in this article will not require more than the equations of plane trigonometry. The primary steps of the previous discussion of the planimeter will be here repeated, and applied to the instrument under consideration, which determines areas as well as the properties specified.

Fig. 1 gives a photograph of the simplest form of the integrator which can be used to determine areas and moments only; it is also the most satisfactory form because the determination of moments of inertia, for reasons to be pointed out later, is likely to be subject to comparatively large errors. Let PQR (Fig. 2) be an irregular figure on a piece of drawing paper for which we wish to determine the area and the moment with regard to the axis xx'. First we place a straight grooved steel track TT' at the proper distance from the axis xx' by aid of the two trams Tt and $T't'$. The trams are then laid aside so as not to interfere with the use of the instrument, which consists of two rigid arms (with appurtenances) hinged at H. This is placed on the paper with the wheels of the guiding carriage C in the groove in the track. The tracing arm HP is used for following the outline of the figure PQR, as with the ordinary polar planimeter. In fact, the instrusent is a form of rolling planimeter, and it will simplify our discussion to ignore the other appurtenances for the moment, and to discuss it as a planimeter only. We have then the guiding arm CH held at right angles to the groove in the track by its carriage C, so that the hinge H moves on the line xx'; and the tracing arm HP, which carries the area wheel W_a. It must be pointed out in passing that the trams Tt and $T't'$ are of exactly the same length as the arm CH, measured from the groove to the hinge; this setting of the instrument is an essential feature for determining moments, but not for areas. The area wheel is carried on an axis parallel to the tracing arm, at any convenient place on that arm; the only essential features are this parallelism, the diameter or circumference of the wheel, and the length of the arm from hinge to tracing point. Near the tracing point is a foot to carry the weight of the instrument at that place; while the frame that carries the area wheel has an elastic connection which allows the wheel to follow the paper even if its surface is slightly irregular. A tracing point shown at the mid-length of the arm in Fig. 1 can be used for tracing small figures.

Suppose now that the tracing arm were removed from the instrument and held in the hand at one side HP of a rectangle having the same length; if the arm were moved parallel to HP over the rectangle to hp the wheel would roll the path W_aw' equal to Hh. The area of the figure is clearly:

$$HP \times Hh = HP \times W_aw'.$$

The instrument represented by Fig. 1 has the tracing arm eight inches long from hinge to tracing point P and the circumference of the wheel is two and a half inches; the diameter is consequently 0.7957 inch. If the width of the figure is two and a half inches the wheel will make one turn during the operation indicated, and consequently one complete turn of the area wheel measures:

$$2.5 \times 8 = 20$$

square inches. The scale on the wheel is divided into one hundred parts and can be read to one-tenth of a part by aid of the vernier; the number of turns is recorded on a dial near the wheel. In using the instrument, it is customary to read the dial, wheel, and vernier before tracing the figure PQR, and again after the tracing, and then to multiply the difference of readings by the factor for area; in this case by 20. For example:

Final reading................	3.754
Initial reading................	2.168
Difference....................	1.586 × 20 = 31.72 square inches.

But the same method of measurement may be applied to a parallelogram like Fig. 4, for while the arm moves from HP to hp the wheel will roll and slide over the path W_aw'; the sliding does not enter into the determination of the area, and may be ignored; the wheel rolls an amount equal to W_aw', which is equal to the altitude of the parallelogram; consequently the area can be found as before by multiplying the difference of readings by the instrumental factors.

In proceeding with the discussion it is convenient to consider the measurement of the area of a special figure like $pqrs$, Fig. 5, which is bounded by two straight lines pq and rs (of which the latter coincides with the axis xx') and by the two circular arcs ps and qr drawn from centers h and h' on the axis xx', with the arm hp for a radius. The reason for selecting this particular figure will be apparent when we come to the discussion of moments and moments of inertia; if we were considering areas only, a somewhat greater freedom of selection would be possible. It may be noted further that the area of the figure $pqrs$ is equal to that of the rectangle $pqmn$, made by dropping perpendiculars from p and q to the axis xx', for the area of psn is equal to the area of qrm; the moments and moments of inertia about the base xx' are also equal, a fact of importance in the discussion of those properties.

Suppose that the integrator is properly mounted on its track TT', with the hinge on the axis xx', and that it is used to trace the figure $pqrs$. There will be four operations: (1) the tracing arm will move parallel to itself from hp to $h'q$; (2) the arm will swing through the angle $qh'r = \alpha$; (3) the arm, which now coincides with the axis xx', will move along that axis to hs; (4) the arm will swing through the angle $shp = \alpha$ to its initial position. Of these four operations, only the first will produce a permanent effect on the measuring wheel W_a. During that operation the wheel will roll and slide over the path wu, the rolling being equal to

$$wu \sin wuv = d \sin \alpha,$$

where d is the length pq. The area recorded by the wheel during this first operation is:

$$L\ d \sin \alpha \qquad (1)$$

where L is the length hp of the tracing arm from hinge to point. But the area of the rectangle $pqmn$ is:

$$A = d\ L \sin \alpha \qquad (2)$$

and that is also the area of the type figure $pqrs$ as already indicated.

As for the other three operations: whatever the effect of swinging the arm from $h'q$ to hr may be, the swinging from hs to hp will neutralize it, while the third operation, with the tracing arm directly over the axis xx', will have no effect, for the axis of the wheel is then parallel to the line xx' and the wheel will slide without rolling. The reading of the wheel after the tracing is complete is consequently exactly the same as it was after the final operation, during which the point moved from p to q, and so far as the determination of area is concerned the tracing might just as well stop there.

*Pages 147, 211 and 248, April, May and June, 1900.

An extension of this method to a combination of several figures, like *pqrs* in Fig. 6, is apparent without going into detail. Again, starting at *w*, the figure *wuvr* may be traced, and then the figure *wrspq* and the difference of initial and final reading multiplied by the instrumental factor will give the sum of the areas of the two simple figures, or the area of *pqwuvsp*. Moreover, the tracing of *rw*, first up and then down, may be omitted and the contour traced

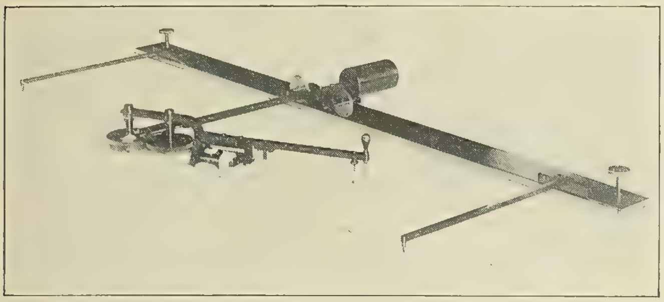


FIG. 1.

directly. In like manner any number of similar figures may be annexed until a complicated contour is measured, including areas like *rvdc* below the axis as well as areas above. To prove this last statement, it is sufficient to consider that in tracing the line *dc* in Fig. 7 the wheel rolls forward just as it does while the line *pq* is traced in Fig. 5; in either case, if one were looking along the arm from the hinge toward the wheel, the latter would be seen to turn in the direction of the hands of a watch.

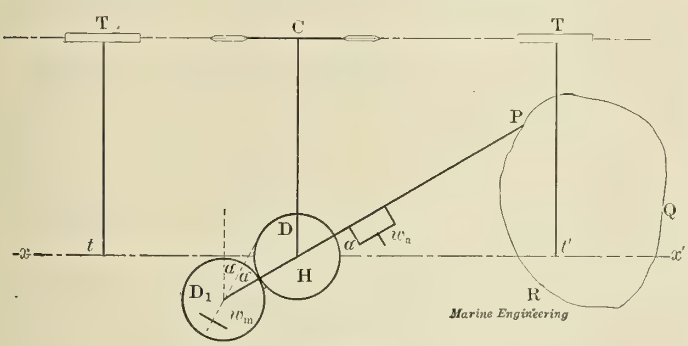


FIG. 2.

In all the preceding discussion it has been tacitly assumed that the figures, simple or complex, shall be traced in right-handed rotation; if any area is traced in the contrary direction its value will be subtracted instead of added.

To pass from the typical figure to any contour, for example to the irregular shape of Fig. 8, it is sufficient to consider that an approximation to the area may be obtained by tracing a contour made up of horizontal lines and circular arcs as indicated, and that we can make the approximation as close as desired by taking as many and as small steps as we please, so that at the limit we

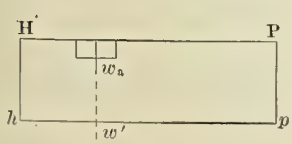


FIG. 3.

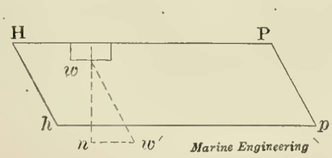


FIG. 4.

may get the correct area by tracing the contour of the figure itself. This conception is the fundamental conception of integration, and must be grasped if a correct idea of the action of a planimeter or integrator is to be obtained; it is thought that its statement, separate from and after the explanation of the mechanism of the instrument, will avoid confusion.

Before taking up the description of the method of determining moments by aid of the instrument represented by Fig. 1, it may be well to consider the nature of the property itself. The primary idea of a movement is simply the product of a force by its distance from an axis about which it may cause rotation. The weight of a body being a force, it is natural to speak of the moment of its weight with regard to an axis; the weight being assumed to act through the center of gravity. If we wish to find the moment of a system of bodies we find the moment of each separately, and add the several moments to find the total moment.

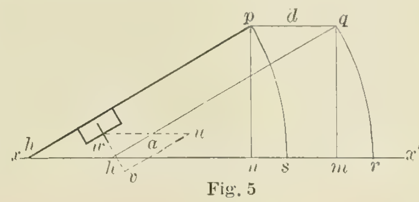


Fig. 5

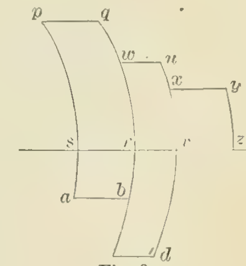


Fig. 6

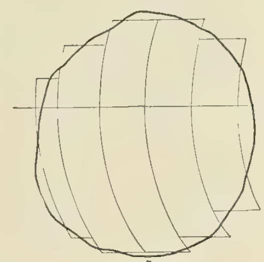


Fig. 8

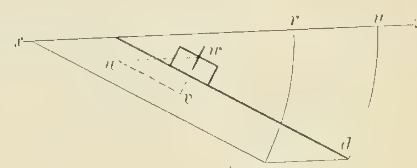


Fig. 7

A very natural extension of this idea gives for the definition of the moment of a plane figure like *ab* Fig. 9, with regard to the axis *xx'*, the product of the area of the figure and the distance of its center of figure from the axis. If the area is one square inch and if its center of figure is one inch from the axis, then the moment is unity. If in Fig. 9 *cd* is considered to represent four

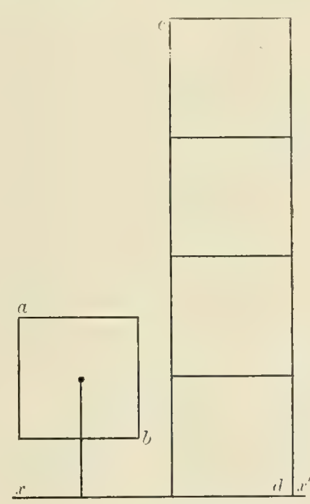


FIG. 9.

adjacent squares, each one inch on the side, then the moments of the several squares will be:

$$\tfrac{1}{2} \times 1,\ 1\tfrac{1}{2} \times 1,\ 2\tfrac{1}{2} \times 1,\ 3\tfrac{1}{2} \times 1,$$

and the sum or total moment will be 8. This result can be otherwise obtained by multiplying the area by half the height of *cd*; thus:

$$4 \times \tfrac{1}{2} \times 4 = 8.$$

A little consideration will show that the moment of any rectangle about its own base as an axis can be obtained by multiplying the area by half the height; so that if the height is represented by *h* and the breadth by *b* the moment will be:

$$M = \tfrac{1}{2}\, h \times area = \tfrac{1}{2}\, h \times h\, b = \tfrac{1}{2}\, h^2\, b \dots\dots\dots\dots (3)$$

Turning to Fig. 5 it appears that the moment of the rectangle *pqmn* is equal to:

$$\tfrac{1}{2}\,\overline{pn}^2 \times pq.$$

But if the length of the tracing arm is represented by L and the angle *phn* by α, then pn may be replaced by $L \sin \alpha$; and of course we may represent pq, the distance the tracing point moves, by d. The moment of the rectangle is consequently:

$$\tfrac{1}{2} L^2 \sin^2 \alpha \times d,$$

or, changing the order:

$$M = \tfrac{1}{2} L^2 d \sin^2 \alpha \qquad (4)$$

and since the typical figure can be made from the rectangle *pqmn* by taking away the figure *psn* and adding the equal figure *qvs*, the above expression represents the moment of the typical figure with reference to the axis xx'. If we can show that the instrument represented by Fig. 1 gives a record equivalent to the expression (4) it will be evident that it can be used to measure moments as well as areas.

To show that this can be done, let it first be noted that the guiding arm has rigidly fixed to it a screw-gear wheel and that the tracing arm carries an equal gear wheel engaging with it; this makes the familiar gear known as the sun and planet wheel, which has the property that the gear D_1, Fig. 2, on the tracing arm turns through twice the angle α of that arm. The gear D_1 carries a measuring wheel which is exactly like the area wheel w_a except that its axis is at right angles with the axis xx' when the tracing arm coincides with that axis. Consequently the axis of the moment wheel makes the angle $90° - 2\alpha$ with the axis xx' when the tracing arm is at the angle α with the axis, as shown in Fig. 10. It is evident that when the tracing point P, Fig. 2, moves a distance d on a line parallel to the axis xx' the wheel will roll and slide a like distance, and that it will roll a distance:

$$hi = d \sin\ (90° - 2\alpha) = d \cos 2\alpha \qquad (5)$$

The scale on the wheel w_m is so graduated that it appears to turn backwards; that is, the reading diminishes during this operation, and consequently a negative sign is given to the quantity in equation (5).

When the line *sr* of the typical figure *pqrs* of Fig. 5 is traced the tracing arm coincides with the axis xx', and the moment wheel w_m, whose axis is then perpendicular to the axis xx', rolls the entire distance d, and the reading of the wheel increases during this operation. As was found to be the case with the area wheel in the discussion of area, it can be readily seen that whatever effect is produced on the moment wheel w_m by tracing the arc *qr* will be counterbalanced by tracing the arc *sp*. So that the net effect of tracing the typical figure *pqrs* will be equal to:

$$d\ (1 - \cos 2\alpha) \qquad (6)$$

But a well-known trigonometrical equation allows us to replace the expression (6) by the expression:

$$2\, d \sin^2 \alpha \qquad (7)$$

If this expression is introduced into the equation (4) already deduced for the moment of the typical figure, we must write

$$M = \tfrac{1}{4} L^2 (2d \sin^2 \alpha) = \tfrac{1}{4} L^2 d\ (1 - \cos \alpha) \qquad (8)$$

The extension of the operation of measuring moments by aid of the integrator to an area like Fig. 6 and to any contour like Fig. 8 is in general similar to that already given for areas. There is, however, one important difference, for the instrument subtracts moments of figures or parts of figures that lie below the axis xx'. To see that this is true, consider that in Fig. 10, if one looks at the side of the wheel W_m, to which the scale is attached, it will appear to turn to the right, like the hands of a watch, while in Fig. 11 it turns in the contrary direction.

Coming now to the moment of inertia, we may start with the idea that this property differs from the moment in that the multiplier is to be the square of the distance instead of the distance itself; a statement that is purposely left incomplete, for the time being, because the proper conception of moments of inertia requires the use of the calculus or its equivalent. An attempt will be made to build up the conception from Fig. 9 in somewhat the same method as was used for moments. Let us first multiply each square inch by its distance from the axis xx' and sum up, giving

$$(\tfrac{1}{2})^2 \times 1 + (\tfrac{3}{2})^2 \times 1 + (\tfrac{5}{2})^2 \times 1 + (\tfrac{7}{2})^2 \times 1 = 21,$$

as a first approximation. For a second approximation let us take half squares getting

$$(\tfrac{1}{4})^2 \times \tfrac{1}{2} + (\tfrac{3}{4})^2 \times \tfrac{1}{2} + (\tfrac{5}{4})^2 \times \tfrac{1}{2} + (\tfrac{7}{4})^2 \times \tfrac{1}{2} + (\tfrac{9}{4})^2 \times \tfrac{1}{2} + (\tfrac{11}{4})^2 \times \tfrac{1}{2} + (\tfrac{13}{4})^2 \times \tfrac{1}{2} + (\tfrac{15}{4})^2 \times \tfrac{1}{2} = 21\tfrac{1}{4}.$$

If the same process were extended to quarter squares the result would be 21 10-32; and a continuation of the method would show that as the width of the elementary area decreased the result would approach the limit 21 1-3. And this result can be obtained by taking one-third the cube of the height of the figure; that is

$$\tfrac{1}{3} \times 4^3 = 21\tfrac{1}{3}.$$

If this conception be united with the very simple idea that the moment of inertia increases directly with the *width* of the figure we may write down the common form for the moment of inertia of a rectangle about an axis at its base,

$$\tfrac{1}{3}\, bh^3,$$

when b is the base and h the altitude. It will be appreciated that the dimension just given is rather an illustration than a demonstration, and that it is left incomplete to avoid prolixity.

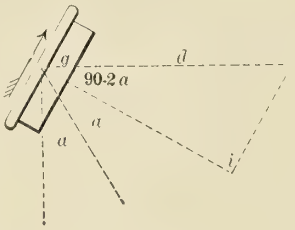


FIG. 10.

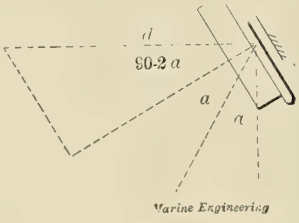


FIG. 11.

The instrument which is designed to measure moments of inertia is represented by Fig. 12, in which the tracing arm carries two circular rack or half-gears, which engage two equal pinions, each of which carries a measuring wheel, making three measuring wheels in all; namely, the area wheel, the moment wheel, and the moment of inertia wheel. The area wheel is carried by the tracing arm in the usual way, and the moment wheel is carried by a pinion geared at a ratio of two to one to the tracing arm; while the moment of inertia wheel is carried by a pinion that is geared to the tracing arm with a ratio of three to one and consequently its axis is turned through three times the angle to which the tracing arm is set, and this is the essential feature of the measurement of moments of inertia.

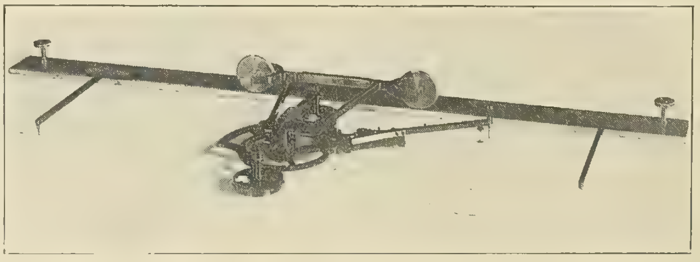


FIG. 12.

Turning to the type area, *pqrs*, Fig. 5, it may be admitted that its moment of inertia is the same as that of the rectangle *pqmn*; that is, to

$$\tfrac{1}{3}\, \overline{pq}\, \overline{pn}^3.$$

But if L is the length of the tracing arm, and α is the angle between it and the axis, and if the line pq is represented by d, then the moment of inertia of the typical figure may be written:

$$\tfrac{1}{3}\, d\, (L \sin \alpha)^3,$$

or

$$I = \tfrac{1}{3}\, L^3\, d \sin^3 \alpha.$$

But the cube of the sine of an angle may be expressed as follows:

$$\sin^3 \alpha = \tfrac{3}{4} \sin \alpha - \tfrac{1}{4} \sin 3\alpha.$$

so that

$$I = \tfrac{1}{4}\, L^3\, d \sin \alpha - \tfrac{1}{12}\, L^3\, d \sin 3\alpha \quad \ldots\ldots\ldots\ldots (9)$$

and it becomes necessary to show how the instrument may be made to give the corresponding records.

As has already been pointed out, the moment of inertia wheel has its axis turned through three times the angle which the tracing arm makes with the axis xx'; and now attention must be called to the fact that, like the area wheel, its axis is perpendicular to the axis xx' when the tracing point is on that line. Though this relation cannot be determined from inspection of Fig. 12 it is easily understood, as are also the consequences of that arrangement. Thus in tracing the typical area, *pqrs*, Fig. 5, the portion *pq* is the only one that need be considered, for the wheel slides without rolling when *rs* is traced, and the effect of tracing the arc *qr* is compensated by tracing the arc *sp*. While the line *pq* is traced, the moment of inertia wheel slides and rolls the distance d, but its axis makes the angle 3α with that line, and consequently it rolls the distance $d \sin 3\alpha$, a factor which appears in equation (9); the other term of that equation contains the factor $d \sin \alpha$ that has already been found to apply to the area wheel, and consequently the instrument furnishes all that is required for using that equation. It should be pointed out that the moment of inertia wheel turns forward when the line *cd*, Fig. 7, is traced, following the method of the area wheel and for the same reasons; and that consequently it *adds* the moments of inertia of figures or parts of figures which are below the axis xx', as it should, for though a distance below the axis may be considered to be negative, its square will be positive.

The tracing arms of the integrators represented by Figs. 1 and 12 are eight inches long, measured from the hinge to the tracing point, and the perimeters of the area wheel and the moment wheel are 2.5 inches (diameter 0.7957 inch); the moment of inertia wheel, as will be explained later, differs slightly. Now it has been shown that for the typical figure the area is

$$L\, d \sin \alpha,$$

where d is the distance traced parallel to the axis xx' and α is the angle which the arm makes with that axis. If the distance $d \sin \alpha$ which the wheel rolls is 2.5 inches, the wheel will make one complete turn and the area recorded will be

$$8 \times 2.5 = 20 \text{ square inches;}$$

and this is the factor by which the difference of reading of the area wheel is to be multiplied to find the area of the figure in square inches.

In like manner, if the net effect of tracing the typical figure is one turn of the wheel, so that

$$d\, (1 - \cos 2\alpha) = 2.5 \text{ inches,}$$

then the moment is

$$\tfrac{1}{4}\, L^2\, d\, (1 - \cos 2\alpha) = \tfrac{1}{4} \times 8^2 \times 2.5 = 40 \text{ square inches;}$$

which is the factor for moments.

Coming now to the moment of inertia, it is to be noted that the wheel is a little smaller than the area and the moment wheel, in fact its perimeter is 2.3438 inches, a diminution which is chosen to get a convenient factor for computation.

In equation (9)

$$I = \tfrac{1}{4}\, L^3\, d \sin \alpha - \tfrac{1}{12}\, L^3\, d \sin 3\alpha.$$

If the area wheel makes one complete turn the product of the distance rolled by one-fourth of the arm cubed gives

$$\tfrac{1}{4} \times 8^3 \times 2.5 = 320.$$

On the other hand, the factor for the moment of inertia wheel is

$$\tfrac{1}{12} \times 8^3 \times 2.3438 = 100.$$

Consequently we have for the integrator with an eight-inch tracing arm the following equations:

$$\begin{aligned} \text{Area} &= 20\, (a_2 - a_1), \\ \text{Moment} &= 40\, (m_2 - m_1), \\ \text{Moment of inertia} &= 320\, (a_2 - a_1) - 100\, (i_2 - i_1); \end{aligned}$$

where a_1 and a_2 are the initial and final readings of the area wheel, m_1 and m_2 are the readings of the moment wheel and i_1 and i_2 those of the moment of inertia wheel.

The instruments represented by Figs. 1 and 12 have a second tracing point at half the length of the arm, that is, at four inches from the hinge, which point may be used for tracing small figures. With a four-inch tracing arm the factors are:

$$\begin{aligned} \text{Area} &= 10\, (a_2 - a_1), \\ \text{Moment} &= 10\, (m_2 - m_1) \\ \text{Moment of inertia} &= 40\, (a_2 - a_1) - 12.5\, (i_2 - i_1). \end{aligned}$$

These instruments, when in good condition, as they come from the makers, are very accurate and can be relied upon to give good results for area and moments; unfortunately they are much less satisfactory for moments of inertia because the formula involves taking the difference of two numbers which are liable to be not very unequal, and this relatively small difference is affected by the entire instrumental error. If we take, for example, a circle tangent to the axis xx', we may have the following readings:

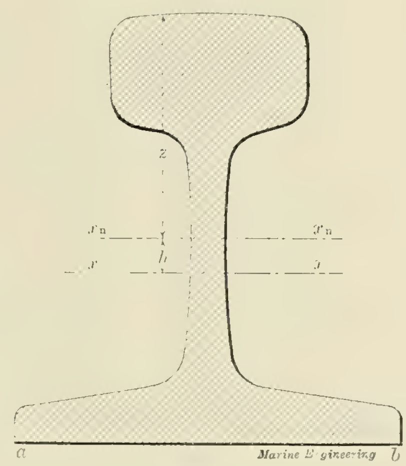


FIG. 13.

	Area	Moment	Moment of Inertia.
First	1.832	4.495	3.721
Second	2.460	5.123	5.103
Difference	0.628	0.628	1.382

$$\begin{aligned} \text{Area} &= 20 \times 0.628 = 12.56, \\ \text{Moment} &= 40 \times 0.628 = 25.12, \\ \text{Moment of inertia} &= 320 \times 0.628 - 100 \times 1.382, \\ &= 200.96 - 138.2 = 62.76. \end{aligned}$$

Now the vernier can be read by estimation to half a thousandth, so that the area may be affected by an instrumental error of one unit in the last place; roughly the error may be taken to be one in the thousandth. The moment should be assigned as large an error, that is, an error of two units, in the second decimal place. The same proportionate error should be attributed to both wheels that affect the moment of inertia; in the example the error should be 0.2 in 200.96 and something larger than 0.1 in 138.2, so that the final error is likely to be at least 0.2 in 62.8, that is about one in three hundred. Even with much practice and skill readings as exact as those quoted are seldom obtained, and practical errors are likely to be much larger.

An important use of this instrument is to determine the moment of inertia of a section like Fig. 13, about an axis through its center of gravity. For this purpose an axis like xx may be taken at random and the area, moment, and moment of inertia can be measured. The quotient obtained by dividing the moment by the area will give the distance h of the center of gravity from xx. To find the moment of inertia about the axis $x_n x_n$, subtract from the moment of inertia already determined with reference to the trial axis xx, the product obtained by multiplying the area by the square of the distance between the axes.

$$I_{xn} = I_x - Ah^2.$$

Should it be desired to use these instruments on a drawing to a reduced scale, we may proceed as with full sized drawings, and then multiply the area in square inches by the square of the reciprocal of the scale, multiply the moment by the cube of that quantity and the moment of inertia by the fourth power. For example, a drawing to the scale of three inches to the foot is to quarter scale. The area is to be multiplied by 16, the moment by 64, and the moment of inertia by 256.

Finally it may be convenient to write down the usual form for the properties which we have been discussing, in the notation of the calculus.

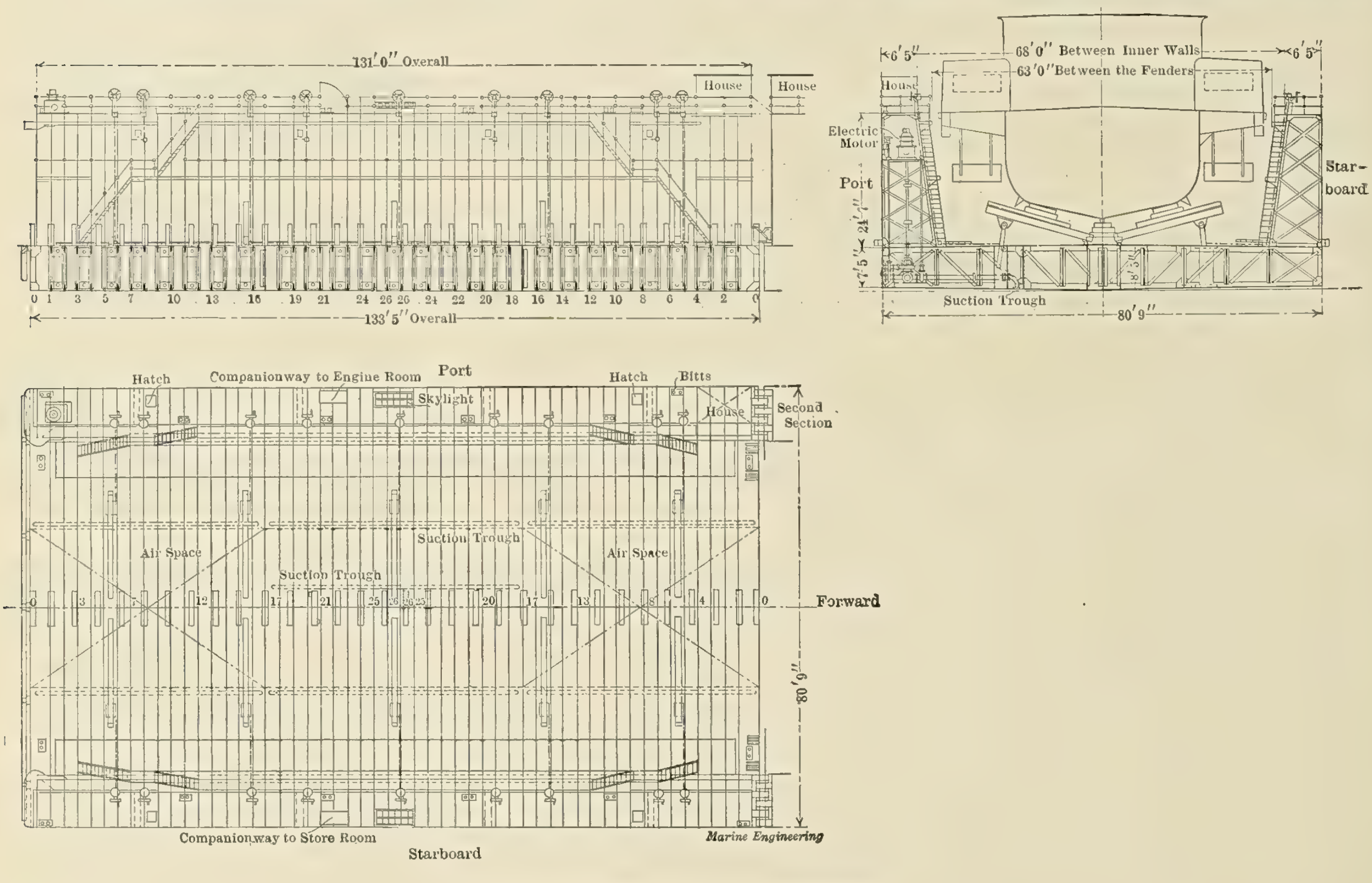
$$\text{Area} = \int\int dxdy = \int ydx,$$
$$\text{Moment} = \int\int ydxdy = \tfrac{1}{2}\int y^2dx,$$
$$\text{Moment of inertia} = \int\int y^2dxdy = \tfrac{1}{3}\int y^3dx.$$

THE FLOATING DOCK OF THE AKTIEN GESELLSCHAFT "NEPTUN," SHIPYARD AND ENGINE WORKS, OF ROSTOCK, IN MECKLENBURG.*

BY KARL ZUBLIN.

A floating dock, which, on account of the new principle involved in it, is especially noteworthy, was set to work last summer by the above mentioned shipyard. Prior to that time the "Neptun" shipyard had not been in possession of docking appliances of their own. For laying vessels dry recourse had hitherto been had to a slipway, which sufficed for vessels of at most 800 tons in weight, with length of about 250 feet, and breadth of about 36 feet. Since, however, the yard had latterly dealt with larger work and even built vessels of about 3,500 tons equipped weight and 370 feet length, such as the *Prinz Sigismund*, for the Hamburg-American Line, it had become more and more necessary for the company to have docking accommodations of their own for vessels of this larger class. The completion of the arrangements for the establishment of a ferry service between Warnemünde and Gedser gave the last impulse to the scheme for the building of a new floating dock.

This dock is constructed on the new "Dieckhoff" system (German patent, No. 150,572; American patent No. 755,854, of March



PLAN AND SECTION OF NEPTUN FLOATING DOCK.

The Mitsu Bishi Dock Yard and Engine Works, of Nagasaki, Japan, are to build two 15,000-ton steamships for the Toyo Kisen Kaisha's service from San Francisco to the Orient. The other Japanese steamship company, Nippon Yusen Kaisha, is having built at the same place a 6,000-ton steamer for its Seattle service. Material for these new steamships and six others is being bought in the United States, and shipments are now being made from San Francisco. Locomotives, rails, and raw material for the new water works at Yokohama are also being shipped, the purchases having been made in this country partly on account of the prices and in part due to the speedy delivery.

29, 1904). The calculations and design of the hull of the dock, as also of its machinery and outfit, were the work of Professor Dieckhoff, of Charlottenburg, while the construction was undertaken by the "Neptun" Shipyard itself.

The dock, which is illustrated herewith, is of the usual U-shaped cross section, and consists in the longitudinal direction of two separate sections which are exactly symmetrical. In this arrangement provision is made for an eventual increase in length, and consequently also of the carrying capacity of the whole structure, by the addition of a third section. The object of dividing the

*Translated for Marine Engineering.

whole structure into several separate parts was that in the case of the docking of several small vessels at once each section might be able to work independently of the others. In this way the work on a vessel which has already been raised by one of the sections can always proceed unhindered while another section is docking or undocking a second vessel. The clear width of the dock has been made comparatively great in view of the eventual docking of the broad paddle steamers plying between Warnemünde and Gedser. In the drawing, a single section is shown, and in the photographs, two such coupled together, viewed from the shore.

below, so as to form a double girder. This arrangement takes the place of the usual diagonally arranged longitudinal structural parts, and has the advantage, that passage-ways are provided between the successive double girders, as also completely unencumbered spaces for the laying of the piping. In the general arrangement of the transverse frames special care must be taken, that on the floors of the compartments, the water, and under their top-plating, the air, can circulate unhindered within the various frame spaces. In view of this both bottom and top plating are laid at a suitable angle with the horizontal on each side. In the case of the deck over the bottom compartments, this also carries with it

END VIEW OF DOCK, SHOWING APPROACHES.

The dimensions are as follows:	m.	ft.
Length over the pontoon of one section	40.662	133.8
Length over the pontoons of the two existing sections	81.650	268.
Length of each side wall	39.91	131.
Extreme breadth over hull of dock	24.612	80.8
Inner width between side walls at top of dock	20.7	67.9
Inner width between wooden fenders at top of dock	19.2	63.
Width of each side wall at top of dock	1.956	6.42
Width of each side wall at height of dock floor	3.15	10.33
Height of pontoons at centre line of dock	2.562	8.41
Height of pontoons at side of dock	2.262	7.42
Height of side walls	7.5	24.6
Height of keel blocks	1.2	3.94
Greatest draught of vessels to be raised	5.5	18.
Freeboard of the side walls therewith	0.65	2.13
Carrying capacity of the two existing sections when the pontoons are allowed suitable freeboard	3,000 tons	

Each pontoon is provided with three longitudinal and two transverse bulkheads. With the exception of the central division all these are made watertight, so that nine separate watertight compartments thus result. The two middle-line end compartments form the necessary air compartments, the rest being arranged for the reception of water.

The transverse frames take the form of lattice girders. As may be seen in the longitudinal section, successive pairs of transverse frames are connected together at certain points above and

the advantage, that the water above it can run off quickly, leaving a dry floor for work under the bottoms of the vessels. Under the dock floor a strong longitudinal girder is arranged within a short distance of the central girder. An advantage connected with this arrangement is, that the keel blocks are not obliged to be placed at one particular point above the transverse frame, but can, in case of repairs to a vessel, be arranged wherever desired, without incurring the danger of bulging in the pontoon top-plating. In accordance with practical requirements, the outer walls of the pontoon are made especially strong.

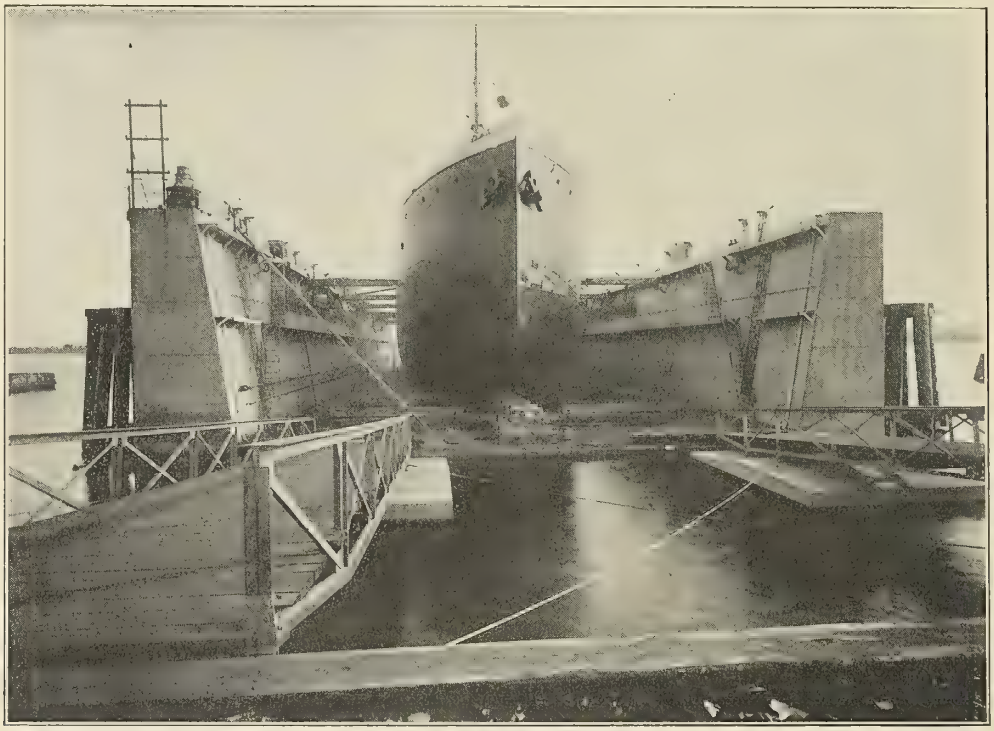
Each side wall contains in its upper portion a watertight compartment, serving at the one side of the dock as an engine room, and at the other as a store room. These spaces at the same time ensure the unsinkability of the whole dock in case the water valves should, through carelessness, be left open. Their size, indeed, is so great that a portion of each of them also serves as an air chamber, and together with the air chambers in the bottom pontoon are capable of supporting the equipped weight of the dock. For ensuring the necessary longitudinal stability of each separate dock-section, the total water space of each side wall is divided by means of two watertight bulkheads into three separate water-chambers.

The equipment of the dock is of very considerable extent. The keel-blocks are made relatively high in order to allow of convenient working under the bottom of a vessel, and are kept very broad and close together in order to minimize the bearing pressure. They consist, in each case, of four open baulks, piled one upon another. Below these are pairs of tapered pieces, which are arranged for wedging up, and fitted with driving rings. The various parts are suitably secured to prevent their swimming away or becoming displaced.

The bilge supports consist in each case of two beams, arranged one above another in such manner that the upper one is free to bend to a certain extent, according to the load that may bear on it. The lower beam is stepped in a socket upon the dock floor not far from the central girder, and is so arranged that its outer end can be moved up and down by means of a rack and pinion. The pinion is actuated from the deck of the side wall by means of shafting and toothed and worm wheels with an automatic braking arrangement. The racks work in shafts extending watertight from the top to the bottom of the pontoon. This whole arrangement is not a very simple one, but it has some noteworthy advantages. By its adoption the building up of the bilge blocks to suit the rise of floor of the docked vessel becomes unnecessary, and vessels of the most varied kinds can be shored up without the forms of their bottoms having to be taken into consideration beforehand. Furthermore, this arrangement enables the bilge supports to be easily loosened and fixed at any time.

made of strong wooden planking, is fitted, along which, at the same time, the heavy ship plates may be transported on bogeys. Bollards, fairheaders, companions, skylights, etc., are suited to practical requirements.

Each section of the dock has a dockmaster's cabin placed on one of the side decks at the end adjoining the next section. At the opposite end is fixed an electrically worked capstan with vertical drum, which is used for drawing the vessels into or out of the dock. Along the outer longitudinal and end walls continuous wooden fenders are fixed to short vertical Z-irons in such a manner that they do not come directly into contact with the skin of the dock, and thus do not afford opportunity for the dreaded rusting which is apt to be produced by contact between wood and iron. The fenders are arranged above the pontoon deck so as to reduce the danger of the sinking of the dock. In case these be heavily strained, the wall plating of the pontoon will, under this arrangement, not be liable to suffer damage. The outer ends of the pontoon are provided each with five vertical wooden fenders. At the entrance end the end-plating of the side



DOCK WITH A SHIP IN POSITION.

walls is in each case provided at the height of the upper dock-shelf with a strong wooden fender as a protection against drifting vessels.

The side-shores are placed in the upper part of the side wall on each side, and arranged to slide on rollers in watertight shafts. These also are worked from the deck of the side wall by means of shafting and toothed and worm wheels. Inner ends of some of the side-shores are provided with rollers, so that in the docking of a vessel, the latter can conveniently be guided, moved, or heeled.

Along each of the inner side walls and extending as far as possible out the entire length of the dock, two dock-shelves made of corrugated iron are arranged, which serve as gangways or as supports for stagings and side-shores in cases of vessels undergoing repairs. The upper dock-shelf lies at a lower level than the side deck, so as here also to provide a good point of support for side-shoring of docked vessels. The inner edge of the dock-shelf is in part provided with wooden fenders. For the lower dock-shelf a handrail is fixed at suitable height along the inner side wall. Several easy stairs lead from the bottom pontoon to the side decks. The lower parts of the former are made to fold, so that in case of need the whole of the clear width between the side walls may, up to a certain height, be made available. Above the floor of the bottom pontoon a broad gangway,

The connection between the sections of the dock is in the form of a hinge arrangement. If the sections of the dock have the tendency to lean toward each other in the longitudinal direction, motion can take place unhindered about the middle of the hinge pin, to a very considerable extent, so that the bulging in of the neighboring end plating which so often takes place in docks of this kind is avoided. For the case in which the sections of the dock tend to lean in different transverse directions only a small amount of play is provided, so that the separate parts can afford support to each other. This support is provided by strong brackets fitted on the pontoon which are made to fit into each other in such a manner that no considerable transverse movement of the sections, one with another, can take place. The whole coupling arrangement is such as to admit of simple and rapid connecting and disconnecting, which is necessary when a single section may be called upon to work independently. It also makes it possible to couple together two sections with a considerable interval (in this case about 30 feet in length) between them, so that a relatively long vessel can be docked, the middle part of which is not then supported from the floor of the dock, but hangs free.

In regard to pumps, each section has two centrifugal pumps with vertical shafts. In order to reduce the height from which the pumps have to draw, and to enable these during ordinary work to reach the point of inlet of the water, they are arranged as low down in the dock as possible. They are fitted directly over the main line of piping, which, resting on the floor plates, runs along one side of the dock. From the main pipe to the various water chambers of the bottom pontoon are fitted branches, which can be shut off by means of water-valves. These branch pipes are connected with a trough which runs along the bottom of the pontoon over the whole length of the various water chambers. In the bottom plates holes are cut above the troughs so that these latter are directly connected with the spaces between the several floor plates. The trough arrangement enables each dock section to be completely emptied by the main centrifugal pumps. It avoids the difficulty otherwise met with that water lodging between the floor plates must either be removed by special piston pumps or remain as irremovable ballast, in which latter case the carrying capacity of the dock is reduced.

Each centrifugal pump is directly coupled to a vertical electric motor fixed in the engine room. There are thus two completely independent sets of pumping machinery provided for each dock section, so that, in case one of these should break down, the dock can be pumped out by the other one alone. The pontoon-chamber inlets and outlets through the skin of the dock are provided with suitable sieves and non-return flaps. Each water chamber of the side walls can be shut off by a simple flap-valve. The total capacity of the pumping plant is so adjusted that, according to the weight of the vessel to be raised by the dock, the time required for emptying the latter is 35 minutes for a weight of about 1,000 tons and 80 minutes for a weight of about 3,000 tons. Each motor is of 20 horsepower, so that the whole plant necessary for the two existing sections has an aggregate of 80 horsepower. The pumping plant which has to be provided in connection with the Dieckhoff patent is thus relatively very small, and its working efficiency is relatively very large. This good result is due on the one hand to the small variation in the depth from which the pumps have to draw; and on the other to the circumstance that instead of the pump suctions having to be throttled, during the process of filling, by manipulations of the check-valves, the suction valves, after the vessel has been berthed, remain completely open, the horizontal adjustment of the rising dock being effected entirely by the help of the check-valve of the side wall.

The lowering of the empty dock from the position in which the pontoon floats with its normal freeboard, is accomplished on the average in 40 minutes. The lowering of the dock with a vessel resting on it varies with the collective weight, but is accomplished in a much shorter time.

The manipulation of the check-valves for the water chambers of the pontoon, and of the side walls, is effected from the dockmaster's cabin as a central station. The latter further contains level indicators for the longitudinal and transverse directions respectively. The whole dock is manœuvred from the central station referred to and speaking-tube connection between the latter and the engine room is provided. After a vessel has been berthed one man is able to fill the dock without having to trouble himself with what may be taking place outside of the dockmaster's cabin. To enable the height of the water in the pontoon chambers to be observed automatic indicators are provided. To enable water to be thrown upon docked vessels for fire quenching and similar purposes, there is a special electrically-driven pump with suitable piping running along the dock, provided with the necessary branches and hose couplings. To enable tools worked by compressed air to be used in the dock a pipe is laid throughout its length provided with branches, to which the compressed air can be led from the shore.

In the engine room is installed a small steam boiler which in winter supplies steam for warming purposes and for thawing the valves and working parts. The lighting of the whole dock is electric. The inner lighting is done by incandescent lamps; the outer by arc lamps. The latter are suspended on booms that can be swung out, or, if necessary, lowered to the dock floor, so that light may be thrown under a vessel's bottom.

The position of the dock in the water is such that its longitudinal axis lies perpendicular to the bank. The traffic with the land is carried on, as shown in the photographs, by means of two broad gangways which at the ends resting on the quay are so arranged that they can turn, and at the opposite ends are borne by suitable pontoons. To preserve its longitudinal direction the dock is guided in the usual manner between several groups of strong piles.

The first floating dock built on this principle was set to work by the firm of H. C. Stülcken Sohn, of Hamburg, on the 23d of April, 1902. In its case both the calculations and the practical comparative trials have established the fact that, compared with the ordinary system as applied under like conditions—that is to say, with given carrying capacity, stability, and time for emptying—the following savings are effected: 47 percent saving in size of pumps and piping; 38 percent saving in size of power plant; 38 percent saving continuous mean consumption of power. Meanwhile, the further advantage is here obtained, that the consumption of power is nearly proportional to the weight of the vessel to be raised, which in a dock on the ordinary system is far from being the case.

Another practical comparative trial with the Stülcken dock, which for this purpose was with very little difficulty arranged to work temporarily on the ordinary system, gave the following result: Under the same conditions—that is to say, with like displacement and draft of the docked vessel, and with the like performance of the power plant—the time required for pumping was 50 minutes when the dock was worked on the ordinary system, and 30 minutes when it was being worked in the Dieckhoff system. This trial, then, showed a saving of 40 percent in time and consumption of power.

The new floating dock of the "Neptun" shipyard has been almost continuously occupied since the beginning of last summer, and has shown itself efficient in every respect.

HOW TO INDICATE THE ENGINE.

BY GEORGE P. PEARCE.

This short article is intended to help the beginner to take his first cards, and so get him interested enough to make a study of the subject; he will then be able to set valves, instantly find out where various troubles lie, run his engine at the highest economy, and thus get the best results.

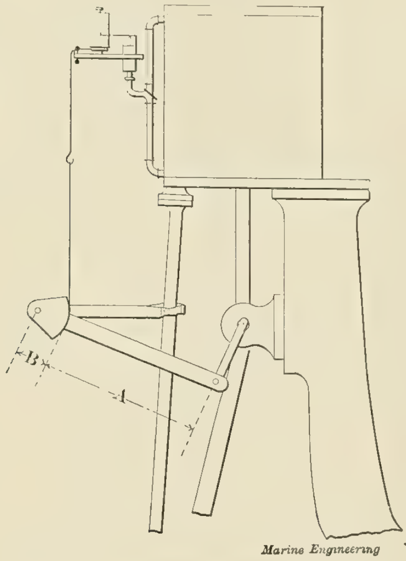
THE INDICATOR.

The first thing to do is to thoroughly clean the indicator, and see that all parts are in good working order. Great care should be exercised in handling, as it is very easy to bend the parallel motion or otherwise destroy its accuracy. Next select the spring; this should be of such strength that it will make the diagram about 1 3-4 inches high, unless the engine is a very high-speed one, when it should be only about 1 1-4 inches. A general rule for getting the right spring is to divide the boiler pressure in pounds per square inch by the desired height of the card in inches, and the result will be the number of the spring. I might mention here that the number of the spring means the steam pressure in pounds per square inch which will be required to lift the indicator pencil one inch; or, a No. 40 spring used under 40 pounds pressure would make a diagram one inch high.

Having selected the right spring, attach it to the piston, carefully oil and get everything ready, place a card on the drum, and get someone to revolve it slightly while you lightly press the pencil against it and draw a line. Now, if the engine is running condensing, measure the distance in inches from this line to the bottom of the card and multiply it by the number of the spring; the quotient should be at least 25 in order to insure plenty of room for the vacuum line. The distance from the line to the top of the card should be about 2 inches. If these are not right the indicator pencil must be adjusted until you get it in the right position; for adjusting the pencil you will find instructions in the box; this arrangement varies with different makes of indicator. After this the indicator is ready to attach to the cylinder.

THE ENGINE CYLINDER.

Next see if the cylinder has indicator pipes for attaching the indicator. If it is an old engine which has never been indicated, you will probably have to drill into the steam passages yourself. To do this it will be necessary to carefully measure how far the piston reaches at each end, and then drill into the clearance spaces, or get as much of the holes as possible there, and chip it into a slot shape so as to be sure that it is of ample size, and that no wire drawing of the steam can take place. The holes should be for a 1-2-inch pipe tap and should be carefully tapped. Next, two short pieces of 1-2-inch pipe with elbows on, should be



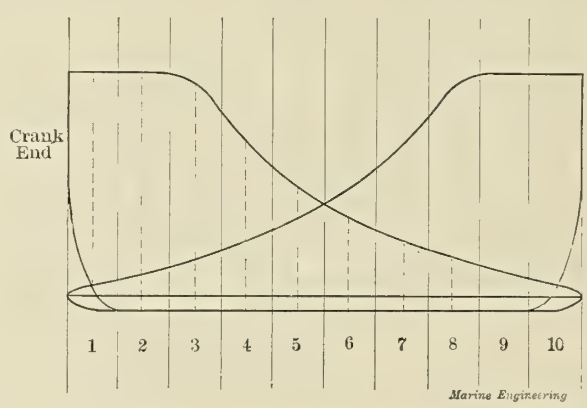
REDUCING MOTION.

screwed in, so as to make a steam-tight joint. I want to warn you against using red lead or any kind of paste in making these joints, because of the bits which are apt to become loosened and get into the indicator cylinder and thus ruin it. If there is any steam leakage, the joint should be loosened and some cotton or twine wound around the threads; this will make them steam tight. Next, two pieces of pipe must be screwed into the elbows, the two ends meeting in the special three-way valve, which is furnished with the indicator. This should be fitted so that the valve will be about in the center of the cylinder. Now, give these pipes a thorough blowing out in order to clean out all dirt, and then all is ready to connect the indicator.

As the indicator diagram should be only about 4 inches long it will be necessary to arrange some device which will reduce the motion of the crosshead to this amount. All modern indicators have a reducing motion attached; if yours is one of these, it will be necessary merely to put a 1-2-inch tap hole in the crosshead, thread the end of a 1-2-inch iron bar, and fit it in. This must be long enough to reach the indicator cord when coming straight from the reducing wheel, care being taken that the cord has a straight to and fro pull without any "wobble," as this would distort the card. If you have no reducing motion you will have to devise one. Perhaps the simplest, and at the same time a very accurate one to make, is the one shown in the cut. The proportions for the parts are: as the stroke of the engine in inches is to the length of the diagram (4 inches), so the length *A* should be to the radius *B*. It is all made from wood except the pins, and the general construction can easily be understood from the cut. The reason for using a quadrant for the cord to run on is to cause the cord to run always in a straight line, and so obtain correct cards.

INDICATING.

Now, attach the indicator; also attach the reducing wheel to the indicator. Next take the cord from the reducing wheel (I am speaking of the modern reducing motion, or wheel, which is attached to the indicator), and move the end or hook over the same distance which it will travel when attached to the iron rod in the crosshead, and thus assure yourself that it is of the right length and will not pull the indicator against the stop. Then throw the indicator out of gear, and by quickly moving the cord to and fro with the crosshead you will be able to catch the loop on the rod, and thus hook up the indicator into gear. Open the indicator valve and let the indicator operate for a short time, so that all will get warmed up. Then put a card carefully around the indicator drum, bringing the ends together just over



INDICATOR CARD PREPARED FOR COMPUTATION.

the prongs, or fork-shaped pieces of metal, and with a sliding motion slip it downwards until it reaches the end of the prongs; if done properly the paper will be quite tight upon the drum. Now, turn the three-way valve so that it will be closed to the back end of the cylinder and open to the crank end, and while the pencil is still oscillating, but not touching the paper, mark down the time in your note book; as the indicator is now thoroughly warmed up and its relative parts expanded, you can close the indicator cock, observing that the little bye-pass is open to the atmosphere. Then draw the atmospheric line by lightly pressing the pencil against the card for a few revolutions. Next open the indicator valve and lightly press the pencil once more against the card, holding it there for about a dozen revolutions of the engine; then disconnect the indicator, take off the card, and mark it "Crank end Number 1." The next card should be taken at once, but on this one get the atmospheric line, crank end, and back end without disconnecting the cord. Take it off, and upon comparing it with the first one you will be able to see which is the crank end. This you should mark, and you will be able to see if the valves are set about right. If everything is correct you should take the speed of the engine, mark down all data in your note book, and then take a card every fifteen minutes,* always remembering to get atmospheric line, crank end, and back end of engine, on each card; also keep filling in your notes. Remember that by getting two diagrams *quickly* on one card you minimize the risk of having the governor move between the first and second diagrams, which would make it appear as if the valves were set wrong.

*In some cases cards are taken every ten minutes.

CALCULATING THE INDICATED HORSEPOWER.

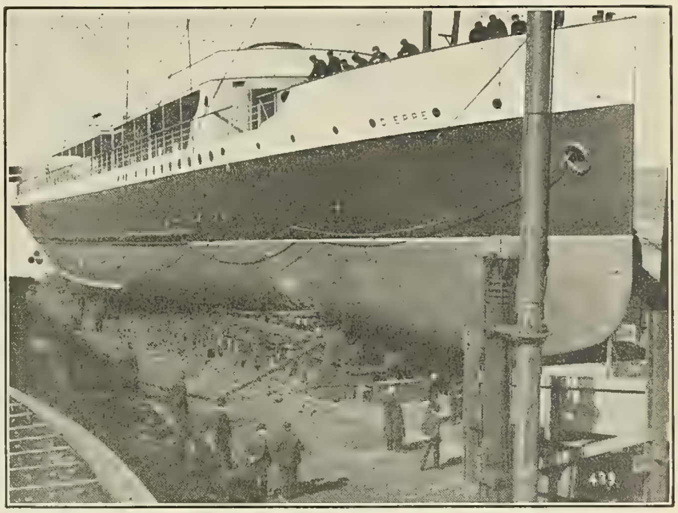
The easiest way to find the mean effective pressure is with a planimeter, but if you have not one, take one of the cards and carefully erect a perpendicular at each end of the atmospheric line, just touching the ends of the diagram. Divide this space into ten equal spaces, and draw ten lines, also at right angles to the atmospheric line. Now, take a point on the top of crank-end diagram line, just half way between the first two lines, and measure the length to a point between the same two lines on the bottom crank-end diagram line. Repeat this on each of the ten spaces (see cut), then add all these measurements together and divide by ten; this will be the average height. An easy way to do this is to take a strip of paper and mark off the first length on it, then mark off the second length, starting from the end of the first, and so on for the ten lengths. It then remains only to measure the length from the first point to the last, and divide by 10. Now, multiply this average length in inches by the scale of the spring and this will give you the mean effective pressure, or the average pressure that was acting on the piston during the stroke. This must be multiplied by the distance which the piston traveled in one minute under pressure from the crank end. This is equal to the number of revolutions multiplied by the stroke in feet. The product will give you the foot-pounds of work done on each square inch of the piston. Next, multiply this by the number of square inches in the area of the piston minus the area of the rod. This will give the total number of foot-pounds of energy developed per minute; divide this by 33,000, and the quotient is the indicated horsepower for the crank end of the cylinder. Repeat this on the back end diagram; but this time you will take the full area of the piston, because there is no rod on that end, unless it is an air compressor or tandem engine, when you will take out the rod area as usual. This result should about equal that for the crank if the valves are set correctly. Add the two together and the result will be the indicated horsepower of that cylinder, and the indicated horsepower of the engine, if it has only a single cylinder. Obtaining the indicated horsepower is only one of the many uses of the indicator, but it is the most usual one.

Launch of Turbine Steamer Dieppe.

On the 6th of April there was launched by the Fairfield Shipbuilding and Engineering Company, Limited, of Glasgow, the triple-screw turbine steamer *Dieppe,* which they have built for the London, Brighton, and South Coast Railway Company's passenger service between Newhaven and Dieppe. The steamer is 274 feet long, 34 feet 8 inches in breadth, and 14 feet 6 inches in depth, and is built to Lloyd's requirements for Channel purposes. She has a promenade deck, all fore-and-aft; also a shade deck of sufficient length to carry all the boats, extending right across the ship, and giving shelter to passengers on promenade deck. On the promenade deck there are the first-class deck saloon, first-class entrance, ladies' boudoir, and a number of special state rooms, all fitted up in a luxurious manner, and having vertical motion square windows. A special feature of the ship is the ventilation arrangements, electric exhausting fans being fitted in the entrance and saloons. A complete installation of electric lights will be fitted.

On the main deck forward there is the first-class dining saloon, which extends right across the ship, and has dining accommodation for 62 passengers. The officers' rooms, galleys, pantries, etc., are arranged on the main deck amidships. On the main deck aft is the second-class passenger accommodation. The sleeping saloons are on the lower deck, sleeping accommodation being provided for over 200 passengers.

The Turbines.—The propelling machinery consists of three independent Parsons' compound steam turbines and two condensers. There are two high-pressure turbines and one low-pressure turbine, and with the former are incorporated the reversing turbines. Each of the three turbines drives a separate shaft, with one three-

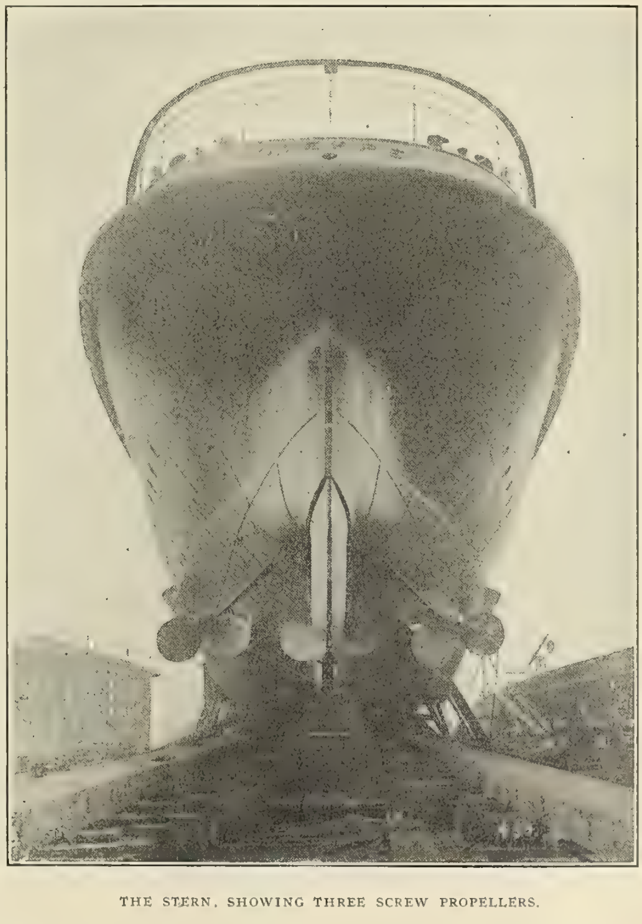


THE DIEPPE READY TO BE LAUNCHED.

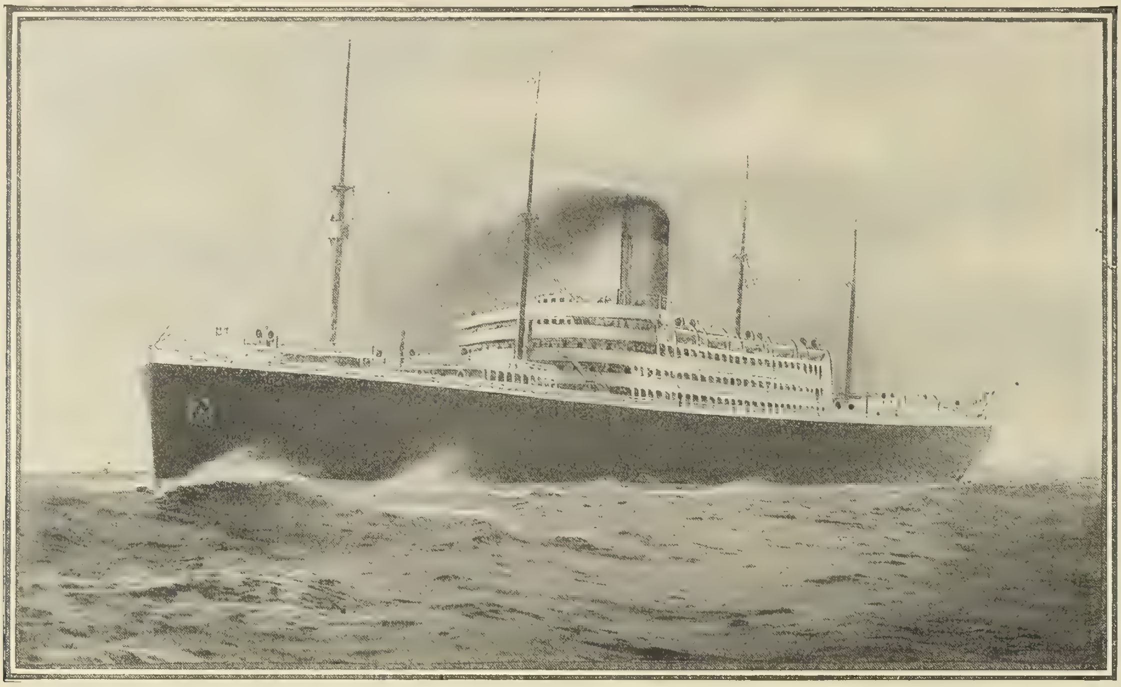
bladed propeller on each shaft. The condensing water is circulated through the condensers by two large centrifugal pumps, one for each condenser, worked by independent engines. The centrifugal pumps are connected to large valves leading to the bilge, so that in the event of accident to the ship these pumps could be utilized for pumping out the engine room. The latter is fitted with all modern appliances, including a large feed filter and a suitable feed heater.

The boilers are four in number, and are single-ended, of the ordinary multitubular marine type, and fitted with Howden's forced draft. They are constructed entirely of steel and adapted for a working pressure of 150 pounds per square inch. The turbines and other machinery have been constructed by the Fairfield Company.

Allan McPherson, Jr.



THE STERN, SHOWING THREE SCREW PROPELLERS.

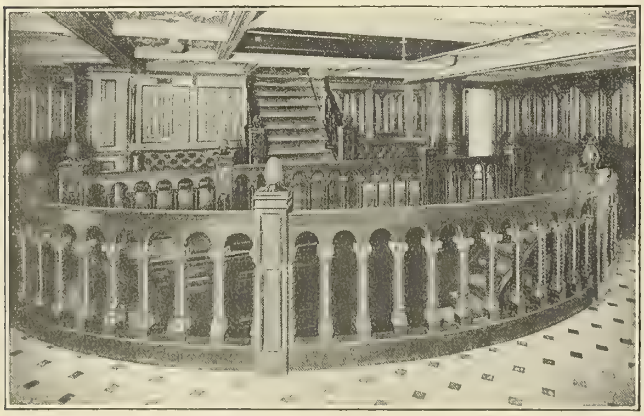


THE STEAMSHIP DAKOTA.

THE GREAT NORTHERN STEAMSHIP DAKOTA.

With the sailing of the *Dakota* from this port, near the end of April, the last large ship constructed for the American merchant marine for over-sea trade has passed out of the hands of the shipbuilders, and for the first time in a good many years there is not now under construction a single American ship for trans-oceanic commerce. The contract for the construction of the *Dakota* and her sister ship *Minnesota,* which is now in service on the Pacific, was let in June, 1901, and was the last contract ever awarded an American firm for ships for this trade.

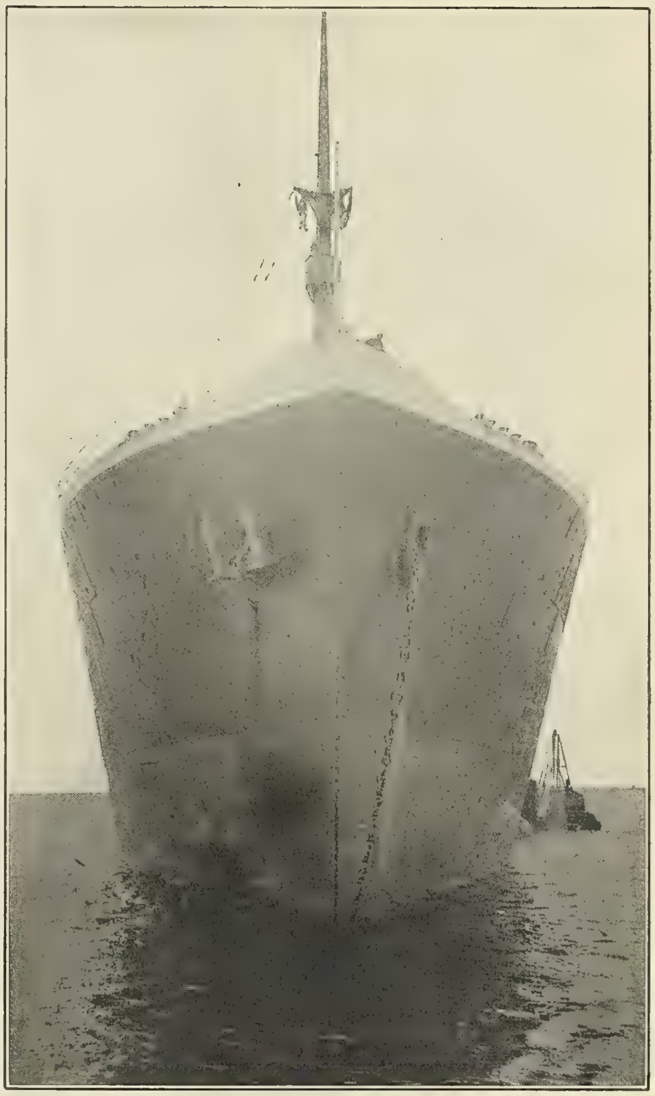
The *Dakota,* which is among the largest ships afloat, measures 630 feet over all, with an extreme beam of 72 feet 6 inches, and a depth from the upper navigating bridge to the bottom of the keel of 88 feet 4 inches; the depth of the hull being 56 feet at the side of the ship, and 57 feet 6 inches at the center line. The load displacement at a draft of 34 feet is about 33,000 tons, while the gross tonnage of the ship is 20,718. This tonnage may be compared with the 21,000 of the *Caronia* and *Carmania,* the 23,500 of the *Baltic* and her new sister ship *Adriatic,* the 20,900 of the *Celtic* and *Cedric,* and the 22,500 of the new Hamburg-American steamers now completing at Belfast and Stettin respectively. The ten ships included in these figures are, we believe, the only ships afloat of above 20,000 tons. It is thus seen that the *Minnesota* and *Dakota* lack very little of being the largest ships in any sea, and it is claimed that when the cargo-carrying capacity is taken as a basis for measurement they are without any exception the largest vessels in existence. The illustrations which we present, showing both exterior and interior views, will give some idea of the mammoth size of these ships, the bow view in particular showing the immense freeboard, which is very striking as the ship is viewed from the pier. It must be remarked in passing, however, that at the time this view was taken the ship was not loaded to



STAIRWAY IN SOCIAL HALL.

FIRST-CLASS SMOKING ROOM.

THE LIBRARY.



BOW VIEW OF THE DAKOTA.

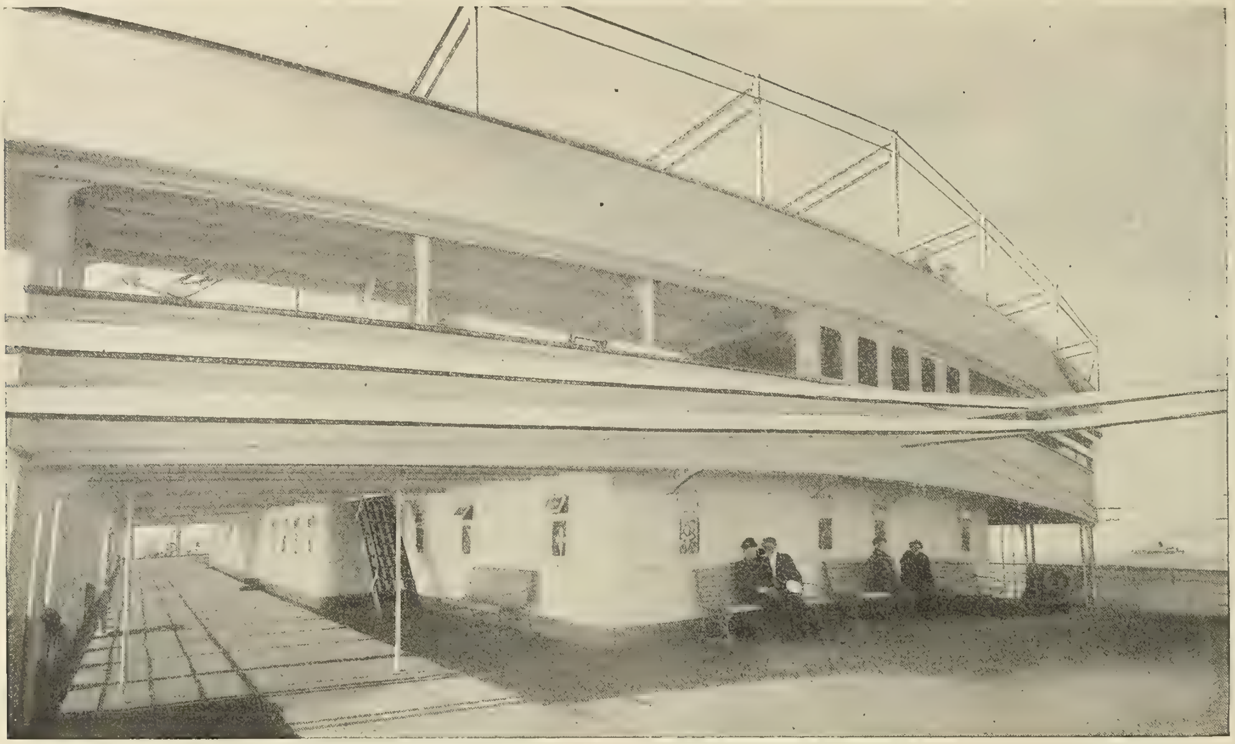
her full draft. Accommodation is provided for about 3,000 passengers, of whom 300 are first-cabin, about the same number second-cabin, and 2,400 third-cabin passengers. If it should be necessary to convert the ship into a troopship, the space devoted to third-class passengers is capable of accommodating 1,300 troops, or, on the other hand, it can be transformed into space for carrying cattle.

The first-cabin passengers are accommodated in the large deck house amidships, and our illustrations show that the accommodations provided for them are most comfortable and luxurious without being in any way gaudy or over-decorated. The large dining saloon, finished in mahogany, will seat about 200 passengers, and is situated at the extreme forward end of the immense deck house, having large light ports on three sides. Above the dining saloon the library is situated on one side of the ship and the ladies' boudoir on the other, both being very attractive quarters for the gathering of passengers in stormy weather. Nearly all of the first-class state rooms have outside windows, while many of them are arranged en suite with bath rooms attached. On the bridge deck is the smoking room, finished in red leather and Flemish oak, while below is a café in which meals may be obtained at all hours of the day and night.

For taking care of the commissary equipment and stores an immense refrigerating plant is installed, operated on the American-Linde system, which is capable of cooling the 300 tons of the ship's provisions in the shape of groceries and vegetables, meat, dairy products, etc., and also of refrigerating as much as 1,700 tons of cargo in the shape of pressed beef. Four large evaporators

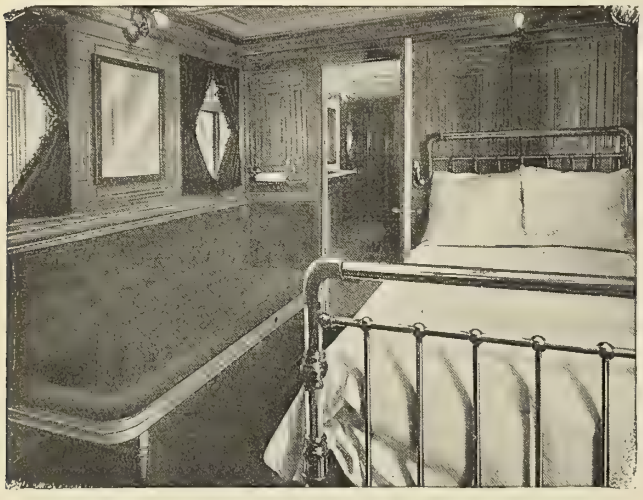
CAFÉ ON MAIN DECK.

A CORNER OF THE DINING SALOON.



THE PROMENADE DECK, SHOWING GREAT BREADTH OF SHIP.

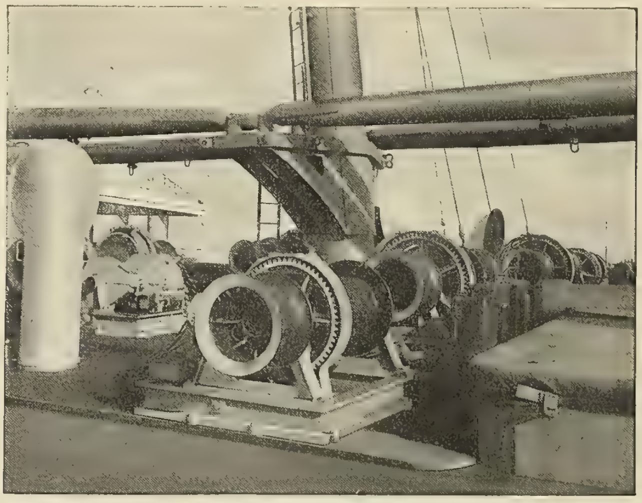
for furnishing fresh water are located in the engine rooms, and provide an abundance of water for both boilers and the use of the crew and passengers. These evaporators have a combined capacity of about 30,000 gallons of fresh water a day. The electric-light plant is very extensive, electricity being used not only for lighting all parts of the ship but for heating the state rooms, running the numerous ventilating fans, and supplying the power for both steering the vessel and operating the cargo-hoisting apparatus. This latter has been so designed as to do away with a large percentage of the men usually found on the deck of a ship when cargo is being hoisted in or out.



ONE OF THE SUITES DE LUXE.

The ship is driven by twin-screw, triple-expansion engines of about 10,000 combined horsepower, and operated by steam at a pressure of 250 pounds, generated by a battery of sixteen Niclausse water-tube boilers. Each engine is located in its separate water-tight compartment, while the boilers are in four similar compartments. One battery of four boilers has been provided experimentally with Duluth stokers manufactured by the Whiting Foundry and Equipment Company, of Harvey, Ill.

On trial trip, for a distance of 59 knots, the *Dakota* required 3 hours and 20 minutes, giving an average speed of 17.7 knots per hour. On this trial the revolutions of the engine were 87 per minute and the total indicated horsepower 10,874. The pressure of steam in the boilers was 245 pounds, and at the engine 215 pounds. Pocahontas coal was used, the consumption figuring out



ELECTRIC CARGO WINCHES.

at 1.75 pounds per horsepower hour. The speed of motion of the automatic grates of the Duluth stokers was 7 1-2 inches per minute. The draft of the ship forward was 17 feet 1 inch; aft, 21 feet 9 inches; mean, 19 feet 5 inches. The diameter of the two propellers is 20 feet, with a pitch of 22 feet.

The American Society of Refrigerating Engineers has issued its first year book, containing constitution and the various by-laws in force up to date. Copies of this book may be obtained by addressing the secretary at Suite 806, No. 258 Broadway, New York.

The Scranton meeting of the American Society of Mechanical Engineers will be held from June 6 to 9 inclusive. The professional papers which will be presented number seventeen.

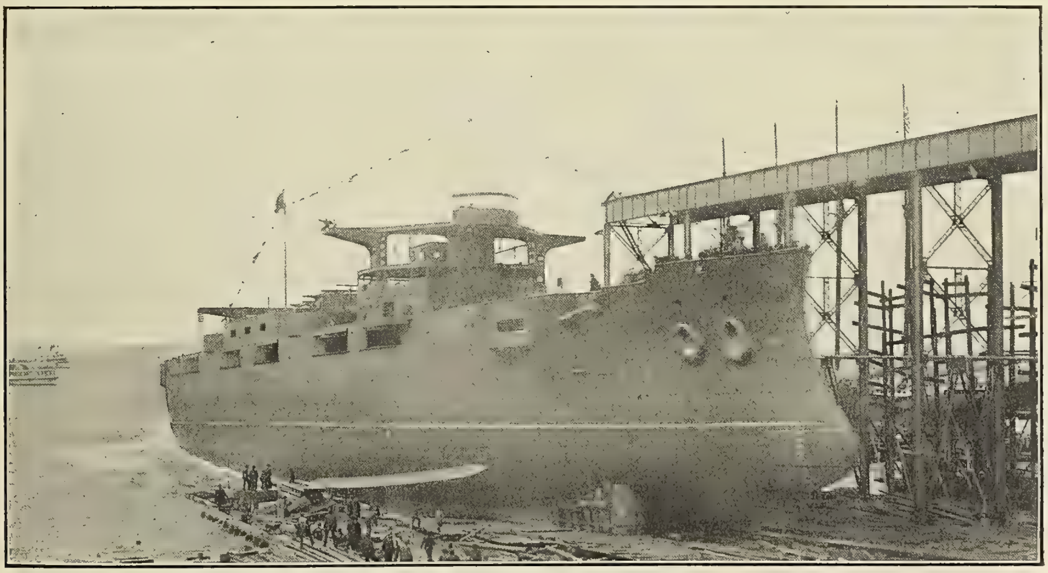
BREAKING THE BOTTLE ON THE BOW OF THE ST. LOUIS.

(Photograph by W. H. Rau.)

TWO NOTABLE LAUNCHES.

On Saturday, April 8, there was launched from the yards of the Newport News Shipbuilding and Dry Dock Company the new United States battleship *Minnesota,* of 16,000 tons, the ceremony being performed by Miss Rose Marie Schaller. This ship is one of several of similar type now under construction for the United States Navy, of which two, the *Louisiana* and *Connecticut,* have been described in MARINE ENGINEERING, at pages 450, of October, 1904, and 489, of November, 1904, while their engines were described at page 198 of April, 1903. As we have already described the ship at some length, we will give here simply a *resumé* of the principal dimensions and features.

The *Minnesota* has a length of 450 feet, beam of 76 feet 10 inches, and at a draft of 24 feet 6 inches will displace about 16,000 tons. Equipped with twin-screw machinery of an aggregate of 16,500 horsepower the speed on trial is designed to be 18 knots. Her normal coal supply is 900 tons, which can be increased when required to a total of 2,200 tons. Steam is furnished by a battery of Babcock & Wilcox boilers. The steaming radius at 10 knots is expected to be 5,000 nautical miles. The battery consists of four 12-inch and eight 8-inch rifles mounted in pairs in six turrets, with twelve 7-inch rifles firing through ports on the gun deck; and a secondary battery of twenty 3-inch rapid-fire guns, twelve 3-pounders, eight 1-pounders, eight machine guns, and two field guns. There are also fitted four submerged torpedo tubes of the new 21-inch type. The water-line belt of armor is of a uniform



THE MINNESOTA ENTERING THE WATER.

thickness amidships of 9 inches, tapering to 4 inches at the bow and stern. The barbettes for the 12-inch guns have thicknesses of 10 and 7 1-2 inches in front and back respectively, while those for the 8-inch guns have thicknesses of 6 and 4 inches. The turrets for the heaviest guns have 12-inch port plates with 8-inch sides and backs, while the corresponding thicknesses for the 8-inch turrets are 6 1-2 and 6 inches. The protective deck has a thickness of 3 inches on the slopes and 1 1-2 inches on the flat. The ship will be manned by a crew of 41 officers and 815 men. The contract for her construction was signed June 20, 1903, the price being $4,110,000; the contract date of completion is December 20, 1906.

The other launch which we illustrate is that of the cruiser *St. Louis,* which left the ways of the Neafie & Levy Company, at Philadelphia, on May 6, the sponsor having been Miss Gladys Bryan Smith, of St. Louis. This ship is a semi-armored cruiser,

THE LAUNCH OF THE ST. LOUIS.
(Photograph by W. H. Rau.)

and is identical in design with the *Milwaukee* and *Charleston,* now being completed at the Union Iron Works of San Francisco and the Newport News Shipbuilding and Dry Dock Company respectively, and described at page 474 of MARINE ENGINEERING for October, 1904.

The length is 424 feet, beam 66 feet, and displacement on a draft of 22 feet 6 inches is 9,700 tons. She is propelled by twin-screws actuated by vertical triple-expansion engines of the four-cylinder type, with cylinders respectively 36, 59 1-2, 69, and 69 inches in diameter and a stroke of 54 inches. At 133 revolutions per minute these engines are designed to develop 21,000 horse-power and drive the ship at a speed of 22 knots. Steam is furnished by a battery of sixteen Babcock & Wilcox boilers. The normal coal supply is 650 tons, which may be increased when necessary to a total of 1,500 tons. The main battery consists of fourteen 6-inch rapid-fire guns distributed upon the upper and main decks, while the secondary battery contains eighteen 3-inch rapid-fire guns, twelve 3-pounders, twelve 1-pounders, ten machine guns, and two field guns. A protective deck is fitted, having a thickness on the slopes of 3 inches and on the flat of 2 inches, while 4-inch vertical side armor is fitted for a considerable length along the midship portion of the vessel. The complement of officers and men numbers 670 all told. The contract for the construction was signed March 11, 1901, the price being $2,740,000.

Wisdom of the Amalgamation of the Line and Engineer Corps of the Navy.

Editor MARINE ENGINEERING:

There has been a great deal said against the amalgamation of the line and engineer corps of the navy, which took place by act of Congress in 1899, but if the subject is carefully studied it will be seen that it is the best arrangement.

The engineer corps was not abolished and the standing of the engineer was not degraded, as has been said, for the line officer is now an engineer officer. Those who are not competent can qualify themselves in either branch, if below forty years of age; and all the younger ones can easily be given a training which will make them competent. Every commissioned officer doing deck or engine duty on a ship should be trained to do either in case part of the complement is killed in action.

No commanding officer who is not an engineer has the knowledge which will enable him to get the best results out of his ship. Too often do commanding officers, who are without engineering training, treat the engine department as if it did not belong to their ship at all, and instead of helping along the officer in charge of it, many obstacles are often thrown in his way, and it is very hard to keep the department in a thoroughly efficient condition. All commanding officers should know what can be gotten out of the machinery and the men of the engineer force under different conditions, and also they should thoroughly understand the difficulties to be surmounted in overhauling and making repairs and keeping the department in a thoroughly efficient condition. They would then certainly consider the engine department as much a part of their ship as any other, and would always lend it a helping hand.

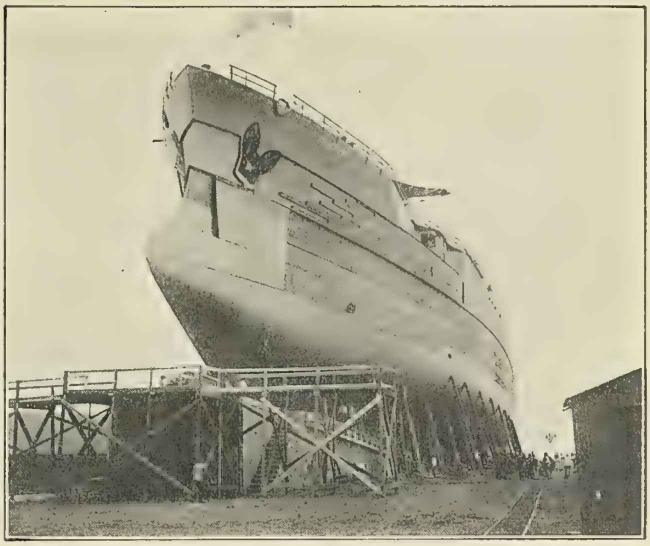
There was no mistake made in the amalgamation of the line and the engineer corps of the navy. What the navy needs is more officers. Those that desire to do so can qualify for engineering duty only. When there are sufficient commissioned officers to give each ship the number for engineering duty that she needs there will be a great improvement. A battleship should have a chief-engineer and six assistants, commissioned officers, instead of a chief-engineer and one assistant, as is the case at present. This shortage of commissioned officers has thrown great strain on those doing engineering duty on the ships.

The warrant machinists are a worthy class; there are doubtless some exceptions, but the greater part of them have neither the education nor the training to fit them for engineer officers. An educated engineer officer is necessary to obtain the best results.

There is really nothing necessary to the proper running of a ship in either deck or engine department that cannot be accomplished with application, by an educated person brought up to sea life. If one has never seen a ship or a machine shop before, the United States laws allow him to (1) qualify as master of ocean steamers in five years, or (2) qualify as chief-engineer of ocean steamers in six years, in the merchant service. Those who wish to specialize along the lines of designing and building machinery and ordnance, and otherwise, can do so, as particular aptitude shows itself. As years go by the mechanical appliances on board ship are increasing. Every part of a gun is a machine. Everything is done by machinery. Seamanship has gone, and all that remains is handling a ship under steam, and the navigation. What is needed now is engineers with training in navigation and in handling steam vessels. The all round training and manual dexterity of Admiral Cochrane, R. N., who could show every man aboard, except the doctor, how to do his work, is as much needed now as it was then. A CHIEF-ENGINEER NOT IN THE NAVY.

The Launch of the French Battleship Liberté.

On the 19th of April the latest of the French battleships was launched from the yards of the Ateliers et Chantiers de la Loire, near St. Nazaire. This ship is one of the *République* class of six ships, which will form a very powerful squadron in the French fleet, and will be distinctive from most of the other ships in that fleet, not only on account of the fact that they are the largest ships yet designed for the French navy, but because of the fact that they are identical in design, whereas preceding ships have in almost every instance been of heterogeneous design, even though built at the same time and given approximately the same elements of military value. Being one of the latest of the *République* class, however, there are a number of improvements incorporated in the *Liberté* which are more in the nature of details than in the main features of the design. One alteration, however, which is of great importance, is the substitution of ten 7.7-inch guns for the sixteen 6.4-inch guns in the earlier ships. The *Liberté* embodies a thoroughly well-studied compromise of all the requirements imposed upon the designer of a modern battleship.



THE BOW, SHOWING ENORMOUS RAM.

In order to institute a comparison between the principal data of this ship and those of the latest battleships of other powers, there is appended a table giving the principal characteristics of one battleship from each of the seven leading naval powers of the world, from which it is seen that the *Liberté* makes a very com-

THE STERN, SHOWING THREE-SCREW SHAFTS.

Navy	England.	United States.	France.	Germany.	Italy.	Russia.	Japan.
Ship	King Edward VII.	Kansas.	Liberté.	Deutschland.	Vittorio Emanuele III.	Imperator Paul I.	Kashima.
Displacement	16,350	16,000	14 750	13,000	12,630	16 630	16 400
Length, L. W. L.	425'	450'	440'	400'	435'	425'	455'
Beam, extreme	78'	76'10"	79'6"	72'	73'6"	78'	78'2"
Draught, mean	26'9"	24'6"	27'6"	25'9"	25'10"	27'	26'4"
Horsepower	18,000	16,500	*18,000	*16,000	*21,000	18,000	21,500
Speed in knots	18.5	18	18	18	21	18	18.5
Armor, water line	9	9	11	9	10	11	9
" for'd, aft	6-3	4-4	6-6	7 and 4	6 and 4	6-6	6.5-6.5
" citadel	8	7	10	5.5	8	?	6
" casemate	7	7	6	6.75	None	None	6
" deck	2	3	2-3	3	4	2.75-4	3
" barbettes	12	10	11	10	10	12	9
" turrets	12-7	10-6	12-5	11	10-6	12-7	9-5
Main battery	4-12" 4-9.2" 10-6"	4-12" 8-8" 12-7"	4-12" 10-7.7"	4-11" 14-6.7"	2-12" 12-8"	4-12" 12-8"	4-12" 4 10" 12-6"
Secondary battery	14-12 lbr. 14-3 lbr. 2 mach.	20-3" 12-3 lbr. 8-1 lbr. 12 mach.	26-3 lbr. 16-1 lbr.	22-3.4" 6-3 lbr. 16 mach.	12-3" 12-3 lbr. 4 mach.	?	12-12 lbr. 12-3 lbr. 6 mach. ......
Torpedo tubes	5-18"	4-21"	5-18"	6-18"	4	4	5
Coal supply	950-2,000	900-2,200	900-1,850	800-1,800	1,000-2,600	?	1,200-2,000
Crew	800	800	750	700	700	900	980

*3 screws.

THE LIBER É AFLOAT.

mendable showing in comparison with most of the others. If we compare her with the *Deutschland* of the German navy, or the *Kansas* of the United States navy, it is seen that her powerful guns could inflict serious damage upon the relatively thin waterline belts of these hypothetical enemies, while her own 11-inch armor belt would render her almost invulnerable to shells from the other ships. The same holds true when we compare her with the English *King Edward VII* and the Japanese *Kashima,* except for the fact that the two latter ships have one knot greater speed, and could therefore engage or not at will, or could choose the distance best suited to themselves in case an engagement was found desirable.

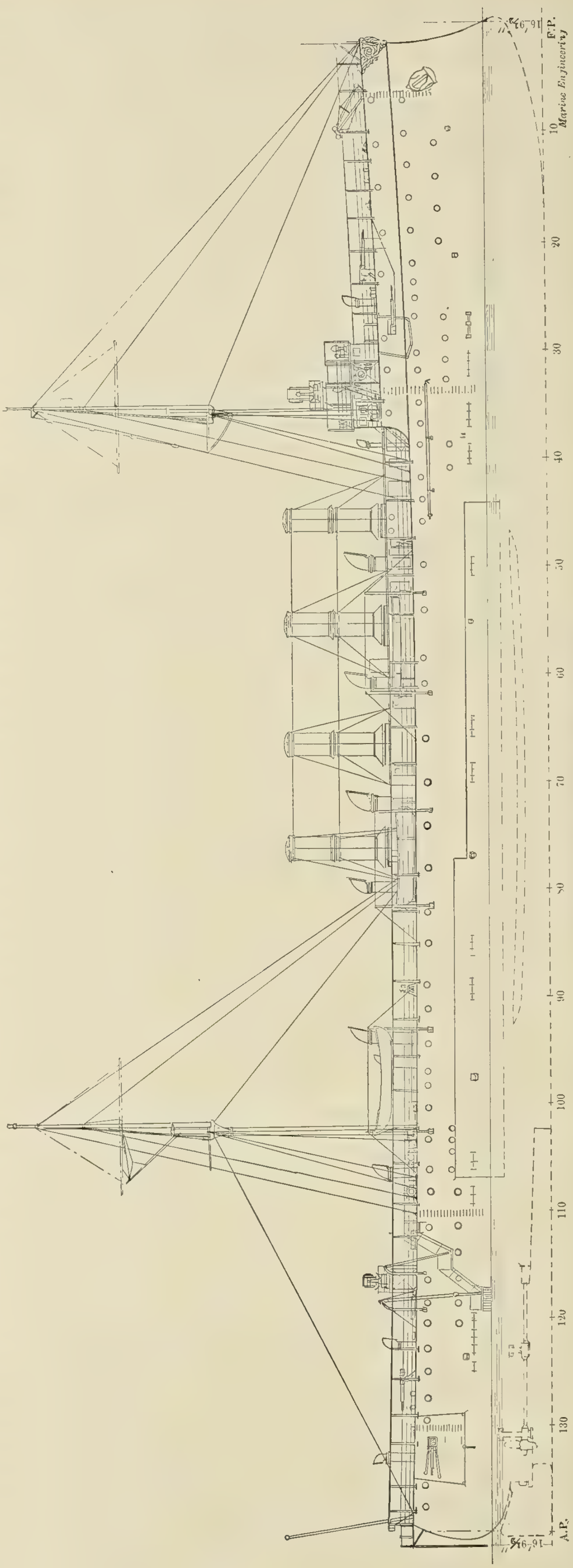
J. Peltier.

THE NEW UNITED STATES SCOUT CRUISERS.

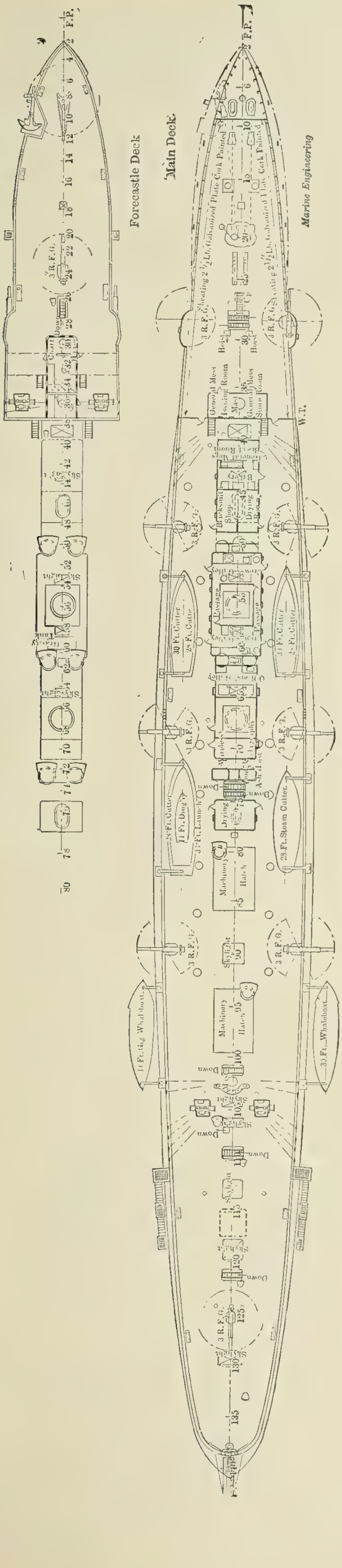
Bids for the construction of three new cruisers for the United States navy, to be known respectively as *Birmingham, Chester,* and *Salem,* were opened by the Secretary of the Navy April 15, and a very large number of bids was found to have been submitted. Five of the large shipbuilding companies on the Atlantic coast, together with the Union Iron Works, of San Francisco, presented bids for constructing the cruisers on the department's plans, with reciprocating engines and twelve water-tube boilers; and the five Atlantic yards submitted alternate bids for the construction of the ships on their own plans, fitted with steam turbines and with varying equipments of water-tube boilers. The successful bidders turned out to be the Bath Iron Works for one ship propelled by Parsons steam turbines, to be constructed in thirty-six months, with a guaranteed speed of 24 1-2 knots, at a price of $1,688,000; and the Fore River Shipbuilding Company, of Quincy, Mass., for two ships, one of which is to be propelled by reciprocating engines and to be completed in thirty months, while the other is to be propelled by Curtis steam turbines and Normand water-tube boilers, each to be constructed at a price of $1,556,000. These were not the lowest bids submitted in the several departments, but the combined features of price and design were considered by the department to embody the best combination of features submitted.

Through the courtesy of the Navy Department we are enabled to present an outboard profile and deck plan of these cruisers, giving a very good idea as to the general appearance which they will have when completed, and the arrangement of the battery of 3-inch guns. The ships have a length between perpendiculars of 420 feet; a beam, molded, of 46 feet 8 inches; and on a draft of 16 feet 9 1-2 inches will displace 3,750 tons. On this displacement, which is that at which the speed trial will be run, they will carry 475 tons of coal and 50 tons of feed water, the total bunker capacity for coal being 1,250 tons. Each ship is provided with a battery of twelve 3-inch rapid-fire guns, mounted as shown in the illustrations, together with two submerged torpedo tubes of the new 21-inch type, which are the most powerful weapons of this sort yet designed.

The engines under the department's plans will be of the twin-screw, four-cylinder, triple-expansion type, with a combined indicated horsepower of 16,000, with the propellers arranged for outboard turning when going ahead. The steam pressure will be 250 pounds per square inch, the stroke will be 36 inches, cylinder diameters respectively 28 1-4, 45, and (two) 62 inches, and the revolutions per minute at full power about 200. Each engine will, as usual, be located in a separate water-tight compartment. The twelve water-tube boilers will be of the express type, placed in three water-tight compartments, and having a total grate surface of 693 square feet and a heating surface of 37,080 square feet, this giving a ratio of heating surface to grate surface of 53.4 to 1. The working pressure in the boilers will be 275 pounds per square inch. The four funnels will have a height of about 75 feet, and the draft provided by them will be supplemented when necessary by fan pressure amounting to about 5 inches of water. The steaming radius at 10 knots per hour is expected to be about 6,250 knots, and at full speed about 1,875 knots.



OUTBOARD PROFILE OF NEW SCOUT CRUISERS.



WEATHER-DECK PLAN OF NEW SCOUT CRUISERS.

In order to insure the ability of these ships to make high speed at sea, and to maintain their speed during all conditions of weather, they have been given very considerable freeboard, amounting at the bow to not less than 34 feet, at the stern to 21 feet 6 inches, and amidships 19 feet 8 1-2 inches, these figures being based on normal draft. This freeboard is considerably higher than that which has been given to any other ship in the United States navy, being even greater than that of the *Brooklyn,* which was at the time of her design higher out of the water than any other warship in existence. This fact will render the scout cruisers quite easy of detection by an enemy at sea, and is in striking contrast to the practice inaugurated by the British navy in the design of the eight scout cruisers now approaching completion for that service. The latter ships resemble very closely an enormous torpedo-boat destroyer, being relatively low in the water and comparatively free from the superstructure features so commonly in evidence on ships of a large size. It remains to be seen whether or not this quality of invisibility possessed by the British cruisers will have a greater military value than the extreme sea-keeping qualities of the American cruisers, together with the fact that their lookouts, being so high above the level of the sea, will have a much greater range of vision than with the lower ships.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, report under date of May 10, 1905, the following percentage of completion of vessels building for the United States Navy:

BATTLESHIPS.			Apr. 1.	May 1.
Virginia	19 knots.	Newport News Co.	83.74	85.53
Nebraska	19 "	Moran Brothers Co.	69.31	70.89
Georgia	19 "	Bath Iron Works	76.44	77.78
New Jersey	19 "	Fore River Shipbuilding Co.	79.4	81.1
Rhode Island	19 "	Fore River Shipbuilding Co.	84.	86.
Connecticut	18 "	Navy Yard, New York, N. Y.	70.24	73.56
Louisiana	18 "	Newport News Co.	71.9	74.83
Vermont	18 "	Fore River Shipbuilding Co.	43.4	47.2
Kansas	18 "	New York Shipbuilding Co.	48.1	51.4
Minnesota	18 "	Newport News Co.	61.76	63.18
Mississippi	17 "	Wm. Cramp and Sons	24.39	27.04
Idaho	17 "	Wm. Cramp and Sons	22.27	24.93
New Hampshire	18 "	New York Shipbuilding Co.	1.5	3.2
ARMORED CRUISERS.				
California	22 knots.	Union Iron Works	73.5	75.
Maryland	22 "	Newport News Co.	99.	99.95
South Dakota	22 "	Union Iron Works	71.3	72.9
Tennessee.	22 "	William Cramp and Sons	69.45	71.8
Washington	22 "	New York Shipbuilding Co.	70.2	74.2
North Carolina	22 "	Newport News Co	2.15	3.25
Montana	22 "	Newport News Co	2.01	3.2
SEMI-ARMORED CRUISERS.				
St. Louis	22 knots.	Neafie and Levy Co.	60.6	63.
Milwaukee	22 "	Union Iron Works	69.8	72.4
Charleston	22 "	Newport News Co.	92.56	93.78
GUNBOATS.				
Dubuque	12 knots.	Gas Engine and Power Co.	90.9	94.28
Paducah	12 "	Gas Engine and Power Co.	82.8	83.9
TRAINING SHIPS.				
Cumberland	Sails	Navy Yard, Boston	95.	95.
Intrepid.	"	Navy Yard, Mare Island	95.	97.5
TORPEDO BOATS.				
Goldsborough	30 knots.	Wolff and Zwicker	99.	99.
O'Brien	26 "	Lewis Nixon	99.	99.

Albert S. Crane has become chief hydraulic engineer of the J. G. White Company, of New York, and will be in responsible charge of the hydraulic department.

Messrs. Sadler, Perkins & Field, marine engineers and contractors, have been incorporated under the same style.

James D. Lamb, of the Lamb Boat and Engine Company, of Clinton, Iowa, was drowned on May 12 in the river near Clinton.

Captain Worth G. Ross, of the revenue cutter service, has just succeeded as chief of that service Captain Shoemaker, retired.

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Power Boats.

We take pleasure in announcing that arrangements have been concluded with Professor W. F. Durand for a series of articles upon the general subject of power boats, of which the first will be published in the July number of Marine Engineering. These articles are to include the entire problem of design and operation, from the laying of the keel to the completion of the craft; and will also look after the management of both boat and machinery when under way. There will also be included observations upon handicap time allowances for racing, as dependent upon both hull and machinery. The series should prove very valuable to designers and owners alike.

Engineers in the Navy.

In another column we publish a communication on the subject of the amalgamation of the line and engineer corps in the United States Navy, which is interesting as well for the large amount of truth it contains as for the considerable modicum of error. The writer of the communication is quite correct when he says that commanding officers in the navy who lack an engineering training are very likely to neglect the engineering departments of their ships, and to hamper with gratuitous obstacles the proper fulfilment of their duties by those charged with the operation of the vast amount of steam and other machinery fitted on board the modern warship. He is quite correct when he says that these commanding officers should have some measure of appreciation of the difficulties to be surmounted, in overhauling and making repairs to this machinery, and keeping it generally in a thoroughly efficient condition. He is very decidedly correct when he states that what the navy needs is more officers, and that the present shortage has thrown a great amount of strain on those now doing engineering duty on the ships.

He is decidedly in error when he states "there is really nothing necessary to the proper running of a ship in engine department that cannot be accomplished with application by an educated person brought up to sea life." The fact of this error is made manifest by the remark a little later down in the same paragraph to the effect that mechanical appliances on board ship are increasing, and that everything is now done by machinery. The Editor has seen cases where a man has gone through college—an educated person, in other words—and has endeavored to assimilate an engineering instinct by taking work in engineering departments under signally competent instruction, but has utterly failed to imbibe anything of that spirit, or to become in any sense a competent engineer. It may not be a thoroughly recognized fact, but it nevertheless *is* a fact, that engineers, like poets, are "born and not made." This fact in itself would militate very strongly against the whole theory promulgated by our correspondent in favor of letting officers perform indiscriminately line and engineering work, without any reference to the especial fitness of the officer in question for the particular work which he is called upon to perform. Another error of this same general character into which our correspondent falls, is when he states that "the all round training and manual dexterity of Admiral Cochrane is as much needed now as it was" in his time. It is entirely superfluous to say that the present is an age of intense specialization, and is daily becoming more so. It is entirely unnecessary to state that in a great profession like engineering the "Jack of all trades" has no place. When it comes to the proposition of handling the exceedingly intricate and delicate machinery outfit in the extremely restricted space allotted to it on a modern warship, most intense application to the particular requirements of the situation are absolutely necessary before any man, naval or civilian, is competent to handle the machinery, and get any sort of results out of it.

Our correspondent has little respect for the present occupants of the much overworked and much berated class known as "warrant machinists," a name which, by the way, is an entire misnomer, as the men bearing it are, in fact, nothing more nor less than assistant engineers, and should be so denominated. If it is a fact, as he states, that "the greater part of them have neither the education nor the training to fit them for engineer officers," the fault lies, not with themselves, but with the system by which they are hounded and kept entirely subservient to men of the "cub ensign" type, who are in many cases of considerably inferior capacity and personality generally, but who may happen to have achieved a somewhat higher rank in the service—with the system which offers them no hope for the future, of attaining anything more desirable than the posts they now occupy. The great shortage of engineering officers has come about largely as a result of the navy personnel bill, which gives the former officers of this class the somewhat higher sounding appellations of "commander," "captain," etc., and places them in line duty rather than in the positions for which they were trained, thereby withdrawing from the engineering staff the very officers who are needed to keep up its status, and maintain conditions in such a state of efficiency as to make the ships of the navy individually and collectively fit for any service to which they may be called, at any time of the day or night, and under any circumstances which may arise.

If sufficient inducement can be offered to enable men from civil life, notably graduates of our engineering colleges, to enter the grade which is now known as that of "warrant machinist," but which, as above stated, ought to be known as "assistant engineer," with some chance of attaining ultimately the post of chief engineer, the problem might be solved in a satisfactory manner; but with the present conditions—with the inherent difficulty of the situation at the best, with the fact that even under the best possible circumstances the work is one requiring the worker to be in the engine room in the midst of dirt and oil for the greater part of his working day—it is little wonder that the number of applications from men educated as graduates of our engineering colleges are educated is very small, and is not likely to increase. Until some such idea is developed, and the berth made worth while for men of this character, it is idle to expect such men to enter it, or to expect any amelioration of the conditions which now exist. The question is one of extreme importance, involving as it does the very foundation of naval efficiency, and is one to which earnest attention should be given by those charged with the work of naval administration.

Marine Machinery.

As announced editorially two months ago, we present with this issue another installment of the articles on the "Design of Marine Machinery," by Professor Durand, and desire to announce that we hope to continue these installments from time to time, until the entire field is thoroughly covered.

The Ocean Yacht Race.

Delayed by heavy fog, the yachts entered in the transatlantic race were prevented from sailing on the date set, May 16, but succeeded in getting away the following day. Everything looks forward to a splendid trial of speed, as the entire eleven yachts crossed the line in less than an hour after the signal was given, and have kept pretty well together up to the date of writing. Speculation as to the probable winner would be fruitless, as the race will probably be decided definitely about the time this issue reaches the readers. With good winds and not too heavy a sea it is quite reasonable to expect that several of the yachts will reach their destination before the close of the month of May.

The Young Merchant and His Servant.

Once upon a time a young merchant just starting in his business career had a very efficient and thoroughly reliable servant upon whom he depended for a large amount of the business which came to him, which business was transacted in a splendidly efficient manner. The business prospered and both master and servant grew in experience and in general breadth of outlook, while the operations extended wonderfully in all directions. After some years had passed, however, the merchant having been gradually drawn away into various other fields of activity, came to neglect his useful servant in such a manner that the relations between the two were by no means the same as had been the case during the first years of their co-operation. Gradually and by almost insensible degrees the merchant began to make use of other servants, not his own, to the exclusion of the services of the one who had been so faithful; and it ultimately came about that he paid large sums of money to these foreign servants because he found that they would do the work for him a little bit cheaper than the one who had been accustomed to doing it, and gradually a large amount of his business passed under the control of these foreign agents. Meanwhile, the honest and faithful servant, not understanding the reasons for the condition of affairs which had become so detrimental to his own prosperity and to the independence of both himself and his master, had begun to languish; his efforts in behalf of his erstwhile indulgent master were no longer so whole-hearted as they had been in the happier days of the early part of the co-partnership. The business fell more and more into the hands of the successful foreign rivals, and things generally were in a very unsatisfactory state.

Thus affairs have continued to this very day, and the people of the United States continue to pay out vast sums of money, amounting to hundreds of millions of dollars, to aid in the upbuilding of the merchant marines of foreign countries, to the exclusion of that of our own.

THE DESIGN OF MARINE MACHINERY.*

BY W. F. DURAND.

PART V.

The Stephenson Link.

(2) *Block Slip.* Introductory to the discussion of the remaining items of a Stephenson link valve gear we must consider the subject of block slip.

Suppose, in Fig. 29, the link block to be made fast in the link at the end *A*, thus guiding or forcing this particular point of the link to move in the straight line *OAV*. Then the system will be completely constrained, and each point of the link will move in a definitely determined path, of which examples are given in Fig. 30, corresponding to various points along the link from one end to the other. Next, suppose that the block is cast loose, as in the normal working of the gear, and the point *R* is taken hold of and in some manner guided in the curved path corresponding to *R*, and as shown at *h*, Fig. 30. Then it will be clear that the point *A* on the link will move, as before, on the center line, and that consequently the link and block will move back and forth without relative motion between the two, or, in other words, without slip of the block.

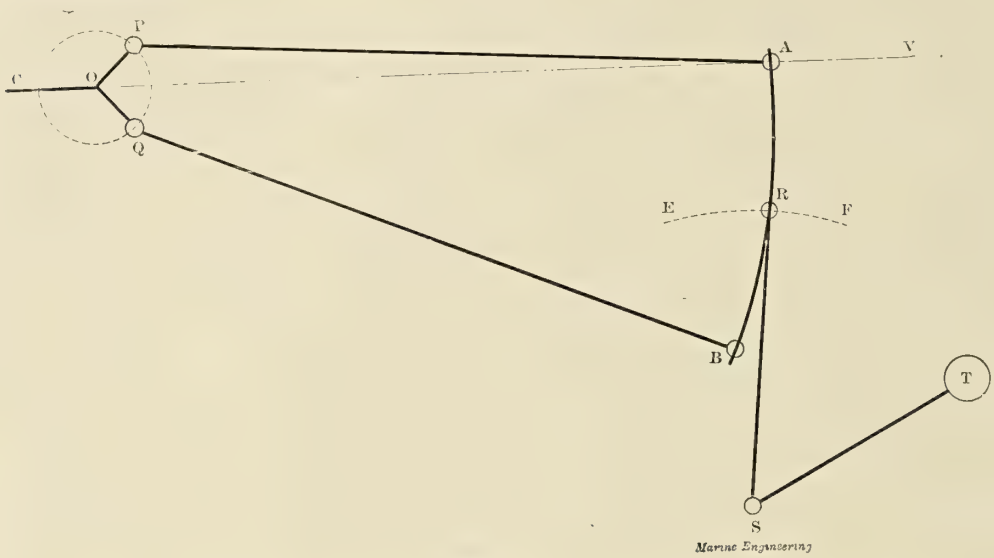

FIG. 29.

Suppose, on the other hand, that the link is controlled by a bridle rod *RS*, and that by reason of the location of the center *S*, this point is forced to move in the arc of a circle, as indicated by *EF*, Fig. 30. Then it will be clear that the point *A*, Fig. 29, cannot now move in a straight line, but must move back and forth across the center line, departing from a straight line path to an extent equal to that by which the curve *h*, Fig. 30, departs from the arc *EF*. Since the link block, however, must move on the center line, it will follow that the operation of the gear will be accompanied by a sliding of the link back and forth on the block, thus producing a relative sliding of the block to and fro in the link.

Inasmuch as the usual means of controlling the link is by a bridle rod such as *RS*, it will be clear that its operation will thus be accompanied by such relative motion of the block and link, depending in amount on the details of the design and the proportions of the gear.

It must not be assumed that block slip is in itself necessarily undesirable, and that it must at all hazards be reduced to the lowest possible limits. If excessive it may result in undue wear on both link and block, and the vibration of the link to and fro may enter as a factor into the problem of ship vibration. Block slip, however, should be considered simply as one of the factors in the operation of the gear, and its influence for good and ill must be weighed with that of other items, and holding in view the general purposes to be fulfilled by the problem in hand. In particular, as we shall proceed to show, the fact of block slip may, if desired, be made use of to produce certain modifications in the movement of the valve having relation to the balancing up of the events in the two ends of the cylinder.

By reference to Fig. 16† it will be remembered that in the operation of a gear with single

*Continued from February, 1904, page 94.

†See MARINE ENGINEERING, November, 1903, page 591.

eccentric there is a tendency on the up stroke toward relatively earlier cut-off and earlier events generally, and on the down stroke toward relatively later cut-off and later events generally. Also, by reference to the tabular statement in [11] it will be remembered that linking up the gear gives earlier events, and with the open-rod configuration an increasing lead, while linking out the gear gives later events, and with open rods a decreasing lead.

Suppose, then, that the block slip were such that when the piston is near the point of cut-off on the down stroke the link is pushed over so as to bring the block nearer the middle relative to its mean or average position, while on the up stroke it is forced over in the other direction so as to carry the block nearer the end relative to the mean position. Then it will be clear that in such case there will be a tendency toward a relatively earlier cut-off on the down stroke and later cut-off on the up stroke than would result if the block were fixed in the link at its mean position for the revolution. Such influence would therefore tend to counteract the later cut-off on the down stroke and earlier cut-off on the up stroke, which would result with the block thus fixed. If sufficient in amount this modification may thus result in a very satisfactory equalization of the points of cut-off for the two strokes.

Again, it is usually considered desirable for the better control of the moving parts to give to the valve an earlier opening and greater lead at the bottom of the stroke than at the top. It is seen that this condition may be realized as a result of block slip provided the arrangement is such as to force the link over into a relatively linked up position when the piston is at the bottom of the stroke, and into a linked out position when at the top, estimated each with reference to the mean position for the revolution.

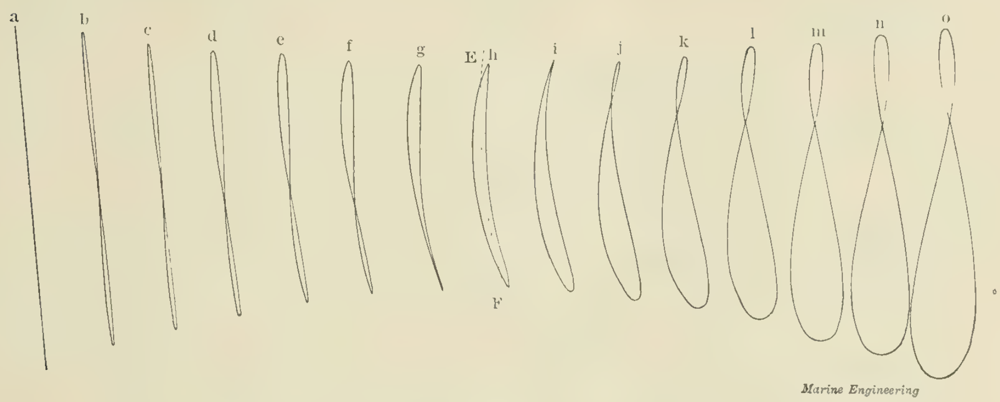

FIG. 30.

It is, of course, true that such changes in point of cut-off and in lead may be brought about by making the steam lap quite unequal on the two ends of the valve, giving less to the bottom than the top. This will tend to give greater lead at the bottom and later cut-off on the up stroke as compared with the top and the down stroke. The attempt to produce any considerable modification in this manner will produce, however, undesirable disturbance in the points of steam opening, and reduction in the width of port opening on top. At best the modification of the lap must be counted in as only one among various means available for bringing about such a final combination of valve events and items of port opening as may be considered most satisfactory for the case in hand.

We shall now turn to a more detailed examination of the subject of block slip, and its relation to the various proportions and configurations of the gear.

In Fig. 29 we assume an open-rod gear fitted to an engine with back columns on the left-hand side (upper side in the figure), and hence with crank turning in the direction of the arrow. With an outside valve also, this gives *P* as the position of the go-ahead eccentric, while *A* will be the go-ahead end of the link. The point of attachment of the bridle or suspension rod is either at *R* or *A*, and so far as possibilities go, the rods may lie either to the right or left, locating in the one case the rock shaft on the front columns and in the other on the back. This will give four possible cases as follows:

(1) Point *R* in middle of link with rock-shaft on front columns.

(2) Point *R* in middle of link with rock-shaft on back columns.

(3) Point *R* at go-ahead end of link with rock-shaft on front columns.

(4) Point *R* at go-ahead end of link with rock-shaft on back columns.

We may note at once that case (4) is not met with in usual practice on account of the short length of bridle rod which would result, and the consequent increase in block slip. This case may therefore be disposed of without further notice.

In Fig. 31, series B, a series of curves is given showing paths of A for case (1). The point of attachment R is taken in each case on the center line of the arc of the link, while the various curves result from shifting the position of the center S parallel to the engine center line. The paths lettered from a to f show the result of a continuous rise* in the center s, producing the transformations throughout the series, and showing the possibilities regarding block slip for these various locations of S with the other items fixed as specified. It will be clear in any given case that the total amount of slip will be given by the total breadth of the curve or path followed by A, estimated at right angles to the line of motion of the valve rod, which in each case is denoted by a vertical line drawn through the curve. This line furthermore divides the total excursion of the point A into equal parts on either side, and it may thus be taken as a convenient reference or center line relative to which the slip of the block on either side of its mean position may be noted.

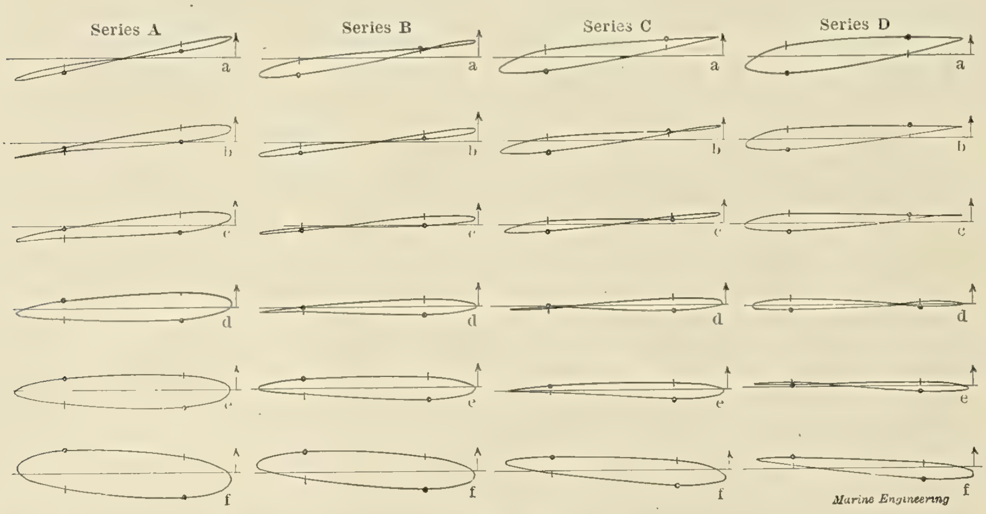

FIG. 31.—OVALS SHOWING PATHS OF GO-AHEAD END OF LINK, CASE (1). IN EACH CASE THE UPPER END OF THE PATH IS DENOTED BY THE SMALL ARROW, WHICH POINTS TOWARD THE BACKING END OF THE LINK.

In Fig. 32, series B, a similar series of curves is given showing paths of A for case (2), the point R being likewise taken on the center line of the arc of the link, while the various paths, as before, result from shifting the position of S in the vertical direction. As in Fig. 31, the curves lettered from a to f show the result of a continuous rise in the center S, and the resulting changes of form show the varying values of the slip as determining by the breadths of the paths, and relative to the center line drawn in each case.

In case (3) the paths of P must necessarily be arcs of circles more or less inclined to the line of motion of the valve according to the location of S. Such a series is shown in Fig. 33, not, however, taken from a model, and somewhat exaggerated in curvature to better bring out the tendencies in this case.

It will next be of interest to note the results of a change in the location of the point of attachment R relative to the center line of the arc of the link. In Fig. 31 are given four series of curves for case (1), and in Fig. 32 four like series for case (2). The series lettered A, B, C, D, result respectively from four locations of the point of attachment R, A just within on the concave side, B on the arc, C just without on the convex side, and D still farther outside. The various paths within each series correspond to a succession of locations of the center S, from below upward in each case, corresponding to progression from left to right in the diagram.

A comparison between similar paths in these various series will then serve to show the effect of shifting the point R across the line of the link in the manner stated.

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*In the present discussion the terms signifying direction have reference to a vertical engine, and not to diagrams like Fig. 29, which are turned down for economy of space.

ABSTRACTS FROM RULES AND REGULATIONS OF THE AMERICAN BUREAU OF SHIPPING FOR OIL-TANK VESSELS ONLY.

EDITION OF 1904.

ARRANGED BY HARRISON S. TAFT.

1. General.

Herein rules, etc., are to cover only that part of ships devoted to an oil or other liquid cargo.

2. Metacentric Height.

Said height should be from 15 to 21 inches for steamers; but from 30 to 36 inches for sailing vessels.

3. Length of Holds, etc.

The fore-and-aft length of an oil tank should not exceed 32 feet.

The oil should go to the skin of the ship. When double bottoms are allowed for water ballast purposes means must be provided for a thorough ventilation of the same. There must be an oil-tight center line longitudinal bulkhead extending to the top of the expansion trunk when said trunk is worked at the center line; otherwise to the "crown deck."

4. Cofferdams.

A cofferdam should be fitted at each end of the spaces devoted to an oil cargo. Fore and aft they should be two frame spaces wide. They are to extend from the keel to at least the deck forming the crown of the oil tanks.

5. Expansion Tanks.

At least one expansion tank is to be fitted to each hold or tank. The capacity of said tanks to be at least 7 percent of the capacity of the hold to which they are fitted for an oil cargo; but 4 percent for a water cargo.

6. Test Pressure Head.

The pressure head for testing tanks should be at least 4 1-2 feet above the top of the expansion tanks; or 12 feet above the "crown deck."

7. Middle Line Keelson.

1. Said keelson is to be 2 pounds heavier than specified for floor plates of ordinary vessels. It should extend above top of floors a sufficient height so as to be embraced by the two continuous fore-and-aft angles on top of the horizontal plate stringers on top of floors (see paragraph No. 2), and to allow of a double riveted lap to the center-line bulkhead plating, with sufficient room for caulking. The lower edge of said keelson is to be secured to a flat plate keel as in ordinary ships.

2. Horizontal plate stringers, each in width at least 3-4 the depth of floors at the center line, and equal to the weight of the center-line keelson, are to be worked on top of floors on each side of the center keelson, and be secured to same by the above fore-and-aft continuous angles.

3. The center-line keelson and floor stringers are to maintain their midship scantling for 1-2 length amidships.

8. Frames.

1. Frames may be of the same flange size as for ordinary vessels, but 10 percent heavier; or of the compound type. They should be cut 8 inches short from the center-line keelson, but they must have a 3-rivet connection to a flat plate keel. Oil- or water-tight transverse bulkheads are to have a single frame bar. Said bar is to be of sufficient flange width to provide for a double row of zigzag rivets to both the shell and bulkhead plating.

2. With a center-line expansion tank all frames are to be cut at the stringer plate of the "crown deck"; said frames being bracketed above and below to said stringer plate with bracket plates 10 percent thicker than the flanges of the frame bars. The brackets on the lower side of said stringer shall have at least a 5-rivet connection to the frames, with a similar connection to the deck beams or stringer plate when single riveted; but a 10-rivet connection when double riveting is called for. The brackets on top of said stringer plates may have a flange or clip connection to the stringer, with same riveting as for the brackets on the under side of said stringer. For a clip connection, the clip flanges must be equal to the thickness of the bracket plate; for a flange connection the weight of said brackets must be 2 pounds heavier than for brackets with a clip connection to said stringer. The width of the clip flanges or of the flange on the plate must be wide enough to meet the size and style of riveting required by said stringer plate. The diagonal edge of the above brackets is to have a 3-inch by 3-inch clip or a 3-inch flange.

3. With a side expansion tank the frames are to extend in one piece to the upper deck; the main deck stringer plate being scored around the frames and fitted with clips to the shell plating. There shall be an angle bar at the face of the frames as for a regular side stringer.

4. The scantling of the frames above the "crown deck" is to be the same as that below said deck on corresponding frames.

9. Floor Plates.

1. The floor plates are to be of the same size and description as the floors in the machinery space of ordinary vessels; or they may be worked straight on top if bracket plates are fitted at the bilge.

2. Floors straight on top are to be 10 percent deeper, or of the same depth and 10 percent heavier than the floors of ordinary vessels; but in no case are they to be less than the lower third of bulkhead plating. The bilge

brackets are to be of the same weight as the floors and are to have a 6-rivet connection to the floors and the frames for single riveting; but a 12-rivet connection for double zigzag riveting. Said double riveting is to be used when the second number is or above 25,000. Said bilge brackets are to be omitted on web frames.

3. In lieu of a stiffening bar on the top edge of the bilge brackets, said edge may be flanged. When the second number is under 19,000 said flange is to be 3 inches wide; when said number is 19,000 and under 52,000, said flange is to be 3 1-2 inches wide; when said number is 52,000 or over, said flange is to be 4 inches wide. Angle-bar stiffeners are to have corresponding flanges and are to equal the thickness of the bracket plates.

10. Reverse Bars.

1. With channel, Z-bar, or bulb angle frames, the reverse bars are to be of the same scantling as for an ordinary vessel. They shall extend from the center line to the outer end of the floor plates on every floor, having reverse clips of the same size at all floor keelsons.

2. With compound frames they are to be of specified size, and shall extend to the upper deck on every frame, being cut at the "crown-deck" stringer.

3. With angle-bar frames, they are to extend to the "crown deck" on every frame.

4. On web frames they are to be worked continuous from the center line to the first side stringer above the floors, and intercostally between the remaining side stringers and the "crown deck." Doubling clips are to be worked at the diamond plate connections of all side stringers.

5. When the deep-frame construction is adopted the reverse bars are to have a 2 1-2-inch lap to the frames when the first number is under 60; a 3-inch lap when said number is 60 but under 100; and a 3 1-2-inch lap when said number is 100 or above.

6. When the shorter flange of the reverse bar is riveted to the top of floors, it is to have a single row of rivets to same, spaced 6 diameters apart; but when the longest flange is riveted to the floors a double row of zigzag rivets, spaced 7 1-2 diameters apart, is to be used.

11. Floor and Bilge Keelsons. Side Stringers.

1. Floor Side Keelsons.

(*a*) Vessels of less than 30-foot beam are to have one intercostal floor keelson on each side of the center line. The intercostal plates are not to be less than 9-10 of the thickness of the floor plates, and they are to extend above top of floors, so as to be embraced and riveted between two fore-and-aft continuous keelson angles. They are to have single clips to the floors and shell plating. They shall extend from peak to peak with the above fore-and-aft angle bars worked continuously through all transverse bulkheads. The intercostal plates are to extend forward and aft as far as possible. When two lines of keelson bars approach each other to within 3 1-2 feet, one line of said bars may terminate at said point.

(*b*) For vessels of 30-foot beam or over see Table 1.

2. Bilge Keelsons.

(*a*) There shall be a double angle-bar bilge keelson at the lower turn of the bilge. A single bulb angle may be used if its sectional area is at least 85 percent of the combined area of the two above angle bars. Said keelson is to be worked continuous from peak to peak.

(*b*) When the beam is 30 and under 36 feet, or 42 and under 48 feet, or 54 and under 80 feet, the above bilge keelson is to have a plate stringer equal to the weight of the floor plates, and in width at least 1-2 the depth of the floors at center line, worked under said keelson bars and riveted to the reverse bars and clips on top of floors (See Table 1). If said stringer plate is cut at a bulkhead, bracket plates equal to the weight of the stringer plate are to be fitted to both sides of the stringer plate on each side of the bulkhead. The width of the bracket plates on the bulkheads is to be at least 3-4 the depth of the floors at the center line, and on the stringer plate one frame space. The brackets are to be double clipped to the bulkheads with both flanges double riveted, and they shall be double riveted to the stringer plate. Said stringer plate is to extend for 3-4 length amidships. In lieu of said plate stringer, a bulb plate of specified depth may be riveted between the two keelson bars.

(*c*) Water-tight collars are to be fitted on both sides of all bulkheads at the floor and the bilge keelson bars, with both flanges double riveted.

TABLE 1.—FLOOR AND BILGE KEELSONS.

Maximum Beam.	Number of Floor Keelsons.	Type of Bilge Keelsons.
Under 30 ft.	1	D A
30 ft. " 36 "	1	D A + H P S
36 " " 42 "	2	D A
42 " " 48 "	2	D A + H P S
48 " " 54 "	3	D A
54 " " 60 "	3	D A + H P S
60 " " 70 "	4	D A + H P S
70 " " 80 "	4	D A + H P S

D A = double angle bars.
H P S = horizontal plate stringer under keelson angle bars.

3. Side Stringers.

(*a*) They are to equal the thickness of the web frames and be worked continuous from bulkhead to bulkhead. They shall be spaced not more than 5 1-2 feet apart, or as stated in Table 2.

(*b*) When said stringers are cut at a bulkhead, bracket plates equal in weight to the stringer plate, extending on the bulkhead from said stringer at least 2 1-2 times the width of said stringer plate and the same distance on the

TABLE 2.—NUMBER OF SIDE STRINGERS.

Height from the Top of Floors to the Stringer Plate of the "Crown Deck."	Number of Stringers.
Not over 11 feet.	1
Over 11 ft., but not over 16½ ft.	2
" 16½ " " " " 22 "	3
" 22 " " " " 27½ "	4
" 27½ "	Hold Beams.

stringer plate from the bulkhead, are to be worked on both sides of the bulkhead. Said brackets are to be connectioned to the bulkhead by a double-riveted flange or by double-riveted angle bars, the thickness of the angle flanges being at least 3-4 the thickness of the bracket plates. The brackets are to be double riveted to the stringer plate and have their diagonal edge flanged.

(*c*) When the plate stringers are continued through a bulkhead, double angle bar collars double riveted in both flanges are to be fitted on both sides of said bulkhead, the flanges being at least 3-4 of the thickness of the stringer plate. Bracket plates, 1 1-2 times the width of the stringer plate on each side with a flanged diagonal edge, are to be worked on each side of the bulkhead; the connection of said brackets to the bulkheads and side stringers being the same as when the plate stringer is cut at a bulkhead.

(*d*) Side stringers are to be clipped to the shell, with the continuous angle bar on the face of the frames as for an ordinary vessel.

(*e*) When the second number is not over 19,000, a single face bar is to be fitted to the inner edge of the stringer. When said number is 19,000 and over, the face bar is to be worked double; the longest flange being vertical in either case.

(*f*) Knee brackets, of at least 85 percent of the weight of the plate stringer, are to be fitted at every frame extending the full width of the stringer plate, with the same width on the frames; but the latter need not exceed 24 inches.

12. Floor Clips.

Reverse frame clips are to be fitted at all keelsons, plate side stringers, and continuous fore-and-aft angle bars. When bulb angle frames are used said clips are to have a 2-rivet connection to the stringer angles.

13. Web Frames.

1. WEB FRAMES are to equal the weight of the floor to which they are attached. They are to be worked on every fourth frame throughout all tanks and machinery space, having at least a single face bar. Said webs are to extend from the floor plates to the "crown deck." They are to be cut at the side stringers, having clips to same with double riveting in both flanges. Besides being riveted to their respective deck beam they are to have bracket plates to said beam of the same weight as the web plates, with at least an 8-rivet connection to said beam and web respectively. When the width of the frame flange permits, the web should have a double zigzag riveted connection to said frame. Diamond plates, equal to the thickness of the web frames, are to be worked at all side stringers. Said plates are to have at least 3 rivets to each face bar on the web frame above and below the stringer angle bar, and 5 rivets on each side of the web face angles to each face bar on the stringers.

2. Between decks, on the bulkhead frames, web plates with a reverse face bar and a double-riveted clip to the "crown-deck" stringer are to be worked throughout the tank space.

14. Deck Beams and Knee Brackets.

1. Beams at web frames; beams at ends of hatchways or other deck openings; hatchway half-beams, etc., are to be deeper than the other beams throughout the oil-tank space.

2. The beams of the "crown deck" are to be spaced at every frame throughout the oil-tank space. They are to extend from the frames to the center-line bulkhead, except in way of hatches where half-beams are to be used. Said half-beams shall have a 4-rivet double-clip connection to the fore-and-afters at said hatches.

3. The upper deck beams should be cut at the expansion tank trunk and be securely fastened to the same with bracket plates and clips, so as to maintain the continuity of strength.

4. Plate knees are to be 2 pounds thicker than the beams, and are to be in depth and width three times the depth of the beam to which they are secured. They should be flanged on the diagonal edge.

5. All hold beams are to be spaced at every web frame. They are to be located so as to connect to the second side stringer down from the "crown deck" with horizontal bracket plates, having at least a 10-rivet connection to the side stringer on each side of the web frame face bar. They are also to have a vertical bracket to the web frame with at least a 6-rivet connection to both the web and the beam. Similar horizontal and vertical brackets are to be worked at the center-line bulkhead. Bracket plates are to equal the weight of the side stringers and web plates.

15. Deck Stringers and Deck Plating.

1. The deck stringer of the "crown deck" is to be as specified for ordinary vessels; except they are to be 2 pounds heavier when the second number is under 25,000; 3 pounds heavier when the second number is 25,000 and under 90,000, and 4 pounds heavier when the second number is 90,000 and over. Said stringer gunwale bars are to be double zigzag riveted.

2. When the expansion tank is located at the sides of the ship, said "crown-deck" stringer is to be secured

by intercostal clips to the shell plating and have a similar angle bar on the face of the frames throughout said tanks as for a regular side stringer. The above face bar is to have a welded knee at the ends of each tank and be worked across the full width of the stringer plate; being riveted to it and through the bulkhead plating to the bounding angle bar on the other side of the expansion-tank plating.

3. The deck plating of the "crown deck" is to be 2 pounds heavier than that of the upper deck of ordinary vessels when the second number is under 36,000; 1 pound heavier when said number is 36,000 and under 72,000; but of the same weight when said number is 72,000 or above. When said deck plating is flanged to connect with the expansion tank plating, said flange plate is to be made 2 pounds heavier than otherwise.

4. When the expansion trunks are worked continuous the strake of the deck plating next to said trunk is to be made heavier as specified.

5. The liners under the upper strakes are to be cut short so as to allow for ventilation.

16. Stanchions.

1. When the beam of a vessel is 42 and under 60 feet, a row of quarter-stanchions is to be worked on each side of the center line. When said beam is 60 feet or above, two rows of stanchions are to be worked on each side.

2. When the length of a stanchion is less than 15 feet, it shall have a 2-rivet connection at each end. When of 15 feet or over, it shall have a 3-rivet connection to the beams, but a 4-rivet connection to floors, with a reverse clip at the latter. Said clip to have a 4-rivet connection to the floors.

3. Stanchions may be worked on the web frame beams only, if a plate girder fitted with double continuous angles on the lower edge is scored around the deck beams; being clipped to the deck plate and bulkheads; and having clips at the heavy deck beams to the said fore-and-aft bottom angles. The head of the stanchion is to be secured to said girder. Said stanchions are to rest upon a flat diamond floor plate, equal to the weight of, and embracing three floors. Said diamond plate is to have a 3-rivet connection to the floors at its ends, but a 6-rivet connection to the floor at its middle when the length of the stanchion does not exceed 15 feet. When the length of a stanchion is over 15 feet, 4 rivets are to be used at the end floors and 8 rivets at the middle floor. But if said stanchion comes on a side keelson said diamond plate may be omitted.

17. Bulkheads.

A. TRANSVERSE BULKHEADS.

1. Said bulkheads are to be spaced not more than 32 feet apart.

2. Bulkhead frame bars are to be worked single, but they are to have a double row of zigzag rivets in each flange. Similar angle bars are to be worked at the junction of a transverse with the continuous longitudinal center-line bulkhead; but they are to be worked on opposite sides, so as to avoid three-ply riveting.

3. The shell liners are to be wide enough to allow of a double row of zigzag rivets on each side of the bulkhead bar.

4. (*a*) Vertical stiffeners of extra weight are to be spaced not more than 4 feet apart, being securely riveted to the floor plates. They are to have top and bottom brackets, with a 6-rivet connection to the stiffeners, but a 5-rivet connection to the deck plating and floor plates. The bracket plates are to be 2 pounds heavier than the lower part of the bulkhead plating. Intermediate stiffeners of regular size are to be worked between the above stiffeners.

(*b*) When the extreme breadth of a bulkhead is 40 but under 55 feet, one web plate, equal to the weight of a regular web frame, is to be worked at the stiffener at the middle of the half breadth. Said webs are to extend from the shell plating to the "crown deck," being one frame space wide for the lower third with a taper for the upper 2-3 to a width of 1-2 of a frame space at the deck. They are to have at least a single face bar equal to the reverse bars of an ordinary ship. Bracket plates, equal to the lower part of the bulkhead plating, are to be fitted to said web in way of the horizontal stiffeners, securing said web to the bulkhead plating in way of said stiffeners. When the breadth is 55 feet or over, two such webs are to be worked on each side of the center line.

5. Horizontal plate stiffeners are to be worked on the opposite side to the vertical stiffeners in range of all the side stringers, to which they are to be bracketed. Said plate stiffeners are to be connected to the bulkhead plating with a single bar, and have a face bar of similar size. When said stiffener plate is over 10 inches in width, bracket plates of the same weight as the stiffener plate are to be worked in way of the heavy vertical stiffeners with a flange or clip connection to the bulkhead plating; having a 5-rivet connection when the second number is under 19,000, but 7 rivets when said number is or over 19,000.

6. The plating and stiffeners of the cofferdams are to be the same as above. The vertical stiffeners should be worked on the inside, with bracket plates equal to lower plating of bulkheads worked on all the heavy stiffeners and in way of all the horizontal stiffeners. Said bracket plates are to have at least a 5-rivet connection on each side.

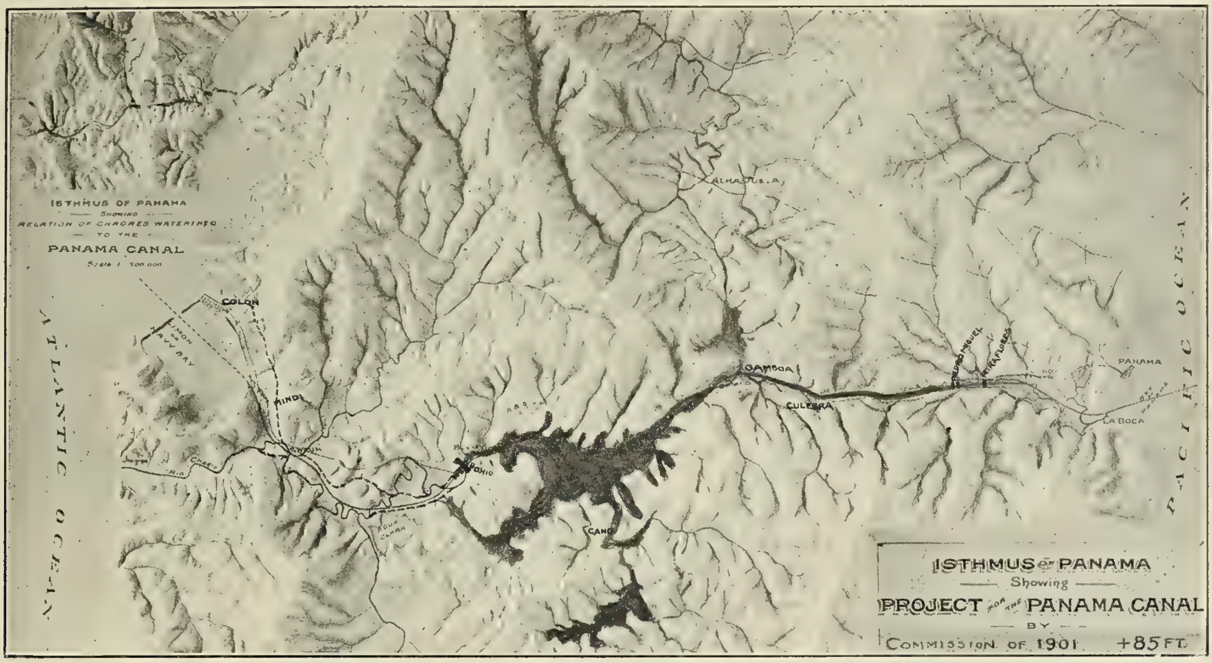
B. LONGITUDINAL BULKHEADS.

1. The plating is to equal that of the transverse bulkheads, except for the top plating to the "crown deck," which is to equal the lower strake of the bulkhead plating. They are to extend to the "crown deck" or to the top of the expansion tank.

2. When worked continuous the longitudinal bulkhead is to be connected to the transverse bulkheads as stated above. When worked intercostally they are to have a single-riveted double angle-bar connection to the athwartship bulkheads. The flanges of said single bars are to equal the thickness of the lower plating.

3. Vertical stiffeners are to be spaced as per frame spacing. Said stiffeners are to be bracketed to the deck beams and to the floor stringer plate. Said floor stringer brackets are to equal the weight of the lower part of the bulkhead plating. They are to have a 5-rivet flange or clip connection to the floor stringer and stiffener angle when the second number is under 19,000, but a 7-rivet connection when said number is 19,000 or over.

(To be continued.)

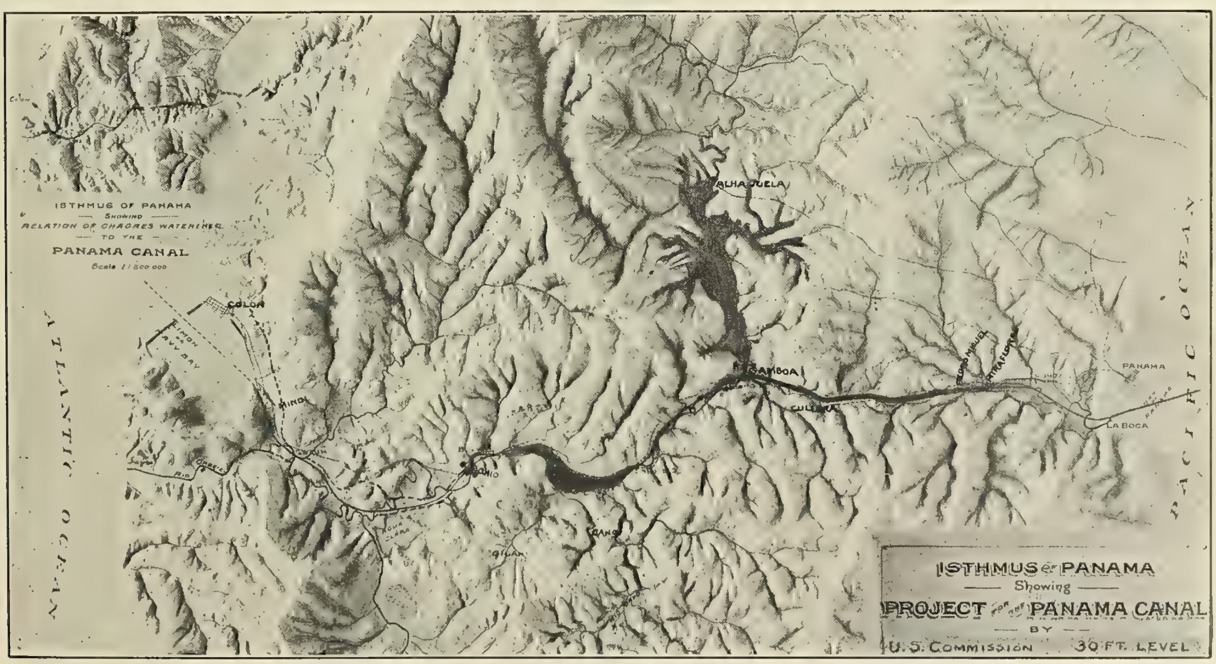


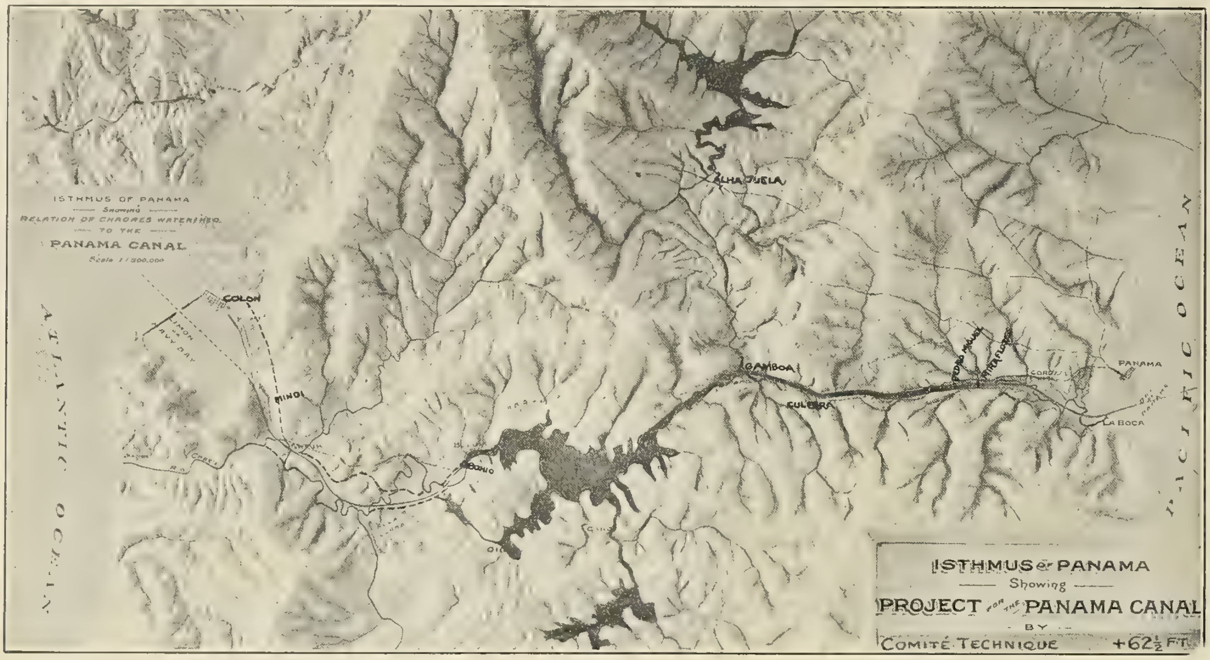
THE PANAMA CANAL.

The six canals, whose plans are given in the accompanying cuts, record the story of one of the greatest public works undertaken in all history. When in 1881 DeLesseps actually began operations they were for a sea-level channel some 29 feet deep. Ships were to traverse it in 1889 and its cost was to reach $127,500,000. When, however, DeLesseps found himself up against the pestilent morasses of the Panama coast and the jungled swamps, the rocky Culebra and the torrent of the Chagres, when 6,000 of his own countrymen lay buried down by the two seas, he had measured forces with Nature truly, and he fell back baffled. After ten years had passed $257,000,000 had been spent and less than two-fifths of his small canal was finished. It was the realization of all that DeLesseps' failure implied, which moved our commission of 1901 to reject a sea-level totally. For a 35-foot sea-level canal it estimated $240,000,000 and a period of at least twenty years.

It is perhaps only natural that, appreciating the combination of natural forces which had so overwhelmed the French with disaster, this first American commission should seek safety above all things and should wish to escape just as far as humanly was possible the perils which proved so fateful to the sea level. It recommended, therefore, a canal at the very other extreme—the 85-foot project.

This is the plan upon whose estimates the Panama investments were bought, and the $145,000,000 appropriated by our Congress. It included a series of big lift locks, consuming much time for their passing. But the higher the channel the less the menace of the dreaded Chagres, and the less chance for duplicating the expenditure of the French, and having no available canal at the end. The 85-foot, like the Comité Technique and the 30-foot plans, all contemplated the same general treatment of the river floods. A very high dam at Bohio must hold back a deep lake several miles in area. Now, Bohio is situated where the river breaks through the median ridge. It is self-evident that an accident to this dam must precipitate the impounded lake upon the lower country in a disaster beside which that of Johnstown would have been slight. The dread of the dam is the reiterated refrain of every report heretofore made on the Panama canal. In a country where earthquakes are far from uncommon, a breach in the Bohio dam was an ever-present menace. Then, too, the water from the sudden tremendous floods must be received in this lake, and its overflow





was the next crucial problem. It could not be left to run down into the canal, so diversion channels, larger than the canal itself, had to be devised. (Shown on maps in dotted lines.)

In the late borings has come a *coup-de-grace* for the 85-foot project. Upon the site of the Bohio there have been found no sure foundations for the very high masonry core-dam it necessitated. This has struck at the very vitals of its possible construction. So it is regarded as abandoned.

The 30-foot has been only vaguely outlined. No detailed estimates have been given out.

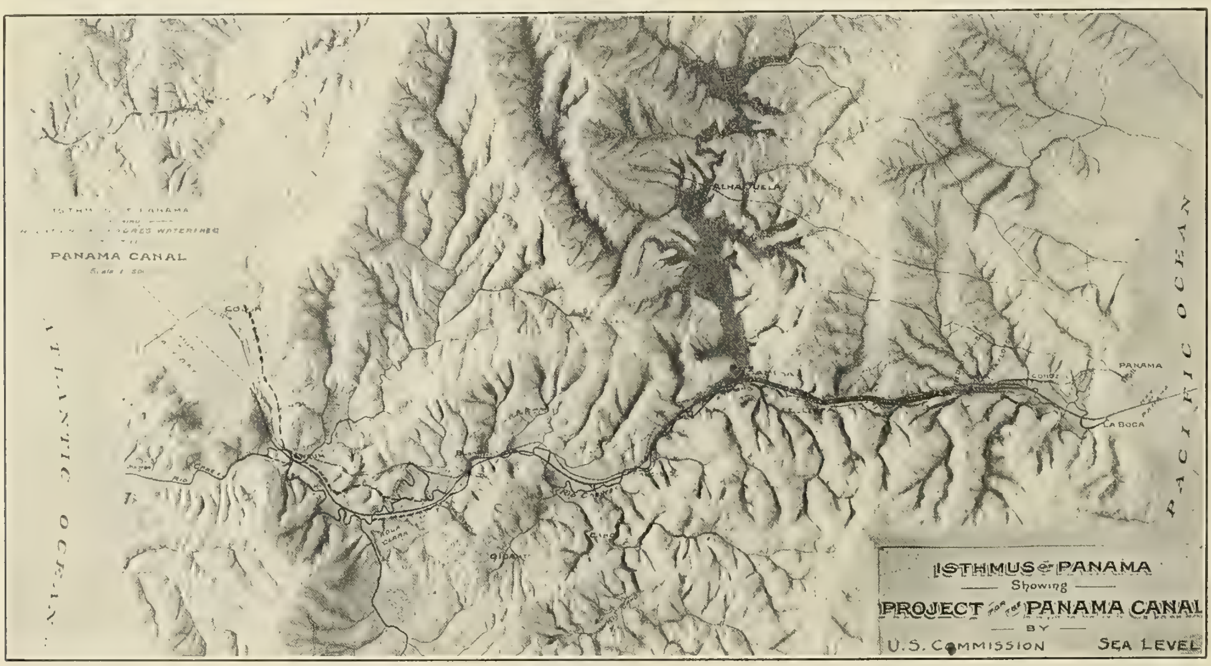
The "new sea level," reviewed and recommended by three members of the last commission and the chief-engineer, advocates a 35-foot channel, and gives the cost for this of $230,500,000. The new Cunarders will draw 37 feet. It is evident, therefore, that a 35-foot depth is quite inadequate for present let alone prospective, needs.

The 62.5-foot canal of the Comité Technique has the same elements, though lesser in degree, of high dams, deep impounded high-level lakes, an unnecessarily tortuous channel, the retention of the death-dealing swamps, an approach hard to negotiate, and with superfluous curves. Its estimate also exceeds the appropriation of Congress.

The remaining canal, that designed by Mr. Lindon W. Bates, is seen to be much more direct and much less curved. From approach to approach it is nearly three sea miles the shorter. It proposes a different entrance from all the others, and on the Pacific end eliminates 66 degrees of curvature. At both termini it creates new town sites by utilizing the material dug from the Culebra. It proposes end locks which shall hold the canal at a level from 20 to 25 feet. These locks are located in rock. Adjacent to one of them the French made a rock cut of 70 feet, so the foundations are beyond question.

Continuous with these locks are built barrages which inclose two terminal lakes, Lakes Chagres and Panama. These terminal locks and lakes are the solution of the first group of problems. The locks being at the end where ships must halt for taking out papers, etc., are passed incidentally without actual loss of time, as is necessitated by the interior lock systems of all the other projects. The lakes give in Project "A" nearly 18 miles, and in Project "B" nearly 26 miles of free, open navigation, in which a vessel can make good speed. This allows a great gain in time over the restricted speed of a tortuous, narrow channel.

The next great feature of the new plan is that these terminal

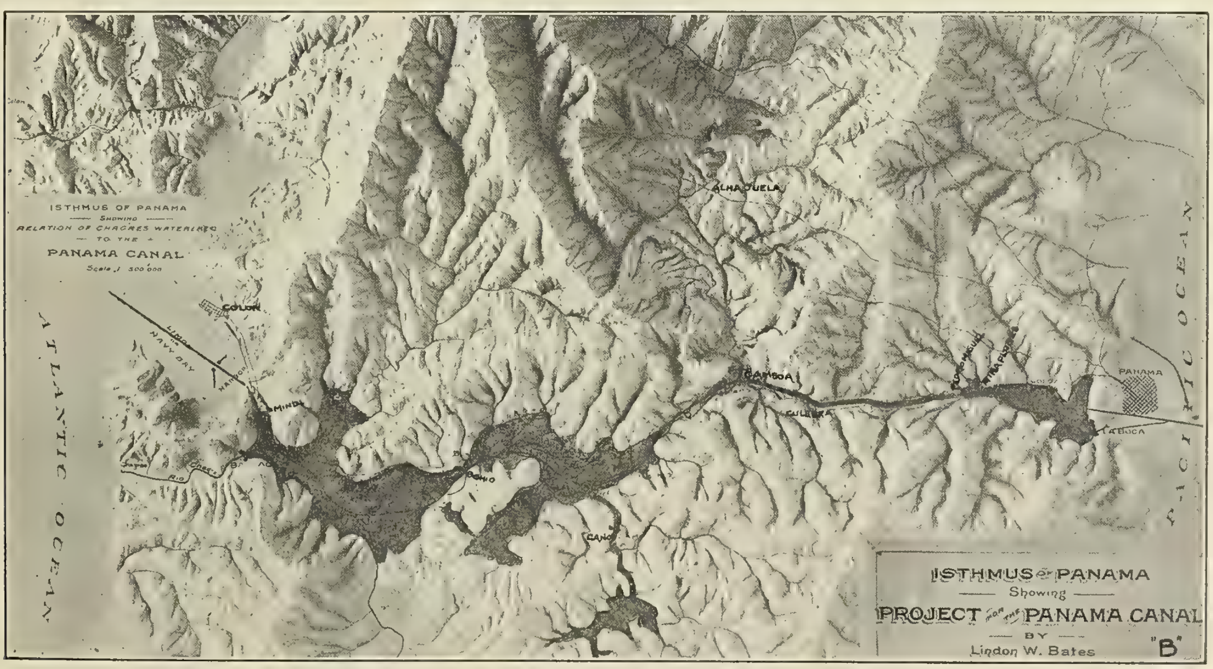


lakes submerge all the fateful swamps which have made the name of Panama almost a synonym for disease and death. This sanitary achievement is winning for the Bates canal the alliance of all the medical journals. It is momentous not alone for the period of construction but for all after time to the residents of the terminal cities and to all the shipping which shall traverse the canal.

The lakes furnish also the means of reducing vastly the unit cost, since they are located where virtually no further work is entailed in their creation save the end dykes. They enable much of the Culebra cut excavated material to be transported by floating plant, which is much the cheapest method of treatment.

The other historical problem, "the Chagres," is attacked from an entirely new point of view by Mr. Bates. Where the commissions have proposed high dams, he substitutes low dams and barrages, such as can with unquestioned safety be built upon the foundations, as borings have actually revealed them. For the head waters of the Chagres he provides catchment basins which are to be empty, except when the sudden torrential floods are temporarily impounded in them. At Alhajuela and Gamboa are built under-sluice dams, by means of which the volume of the river is controlled and its water is fed down to a triangular basin, the Obispo Basin. A gradually expanding ratio is applied to regulating the current toward the lakes. In the Obispo Basin the Chagres is divided into two halves, and each half is led down through the canal itself to either ocean. The halving of the river after its volume has been controlled to the rate of absolute safety takes away the "Chagres terror," which has haunted every one of the thirty odd engineers who have reported upon it. It is stated upon the authority of one long a resident and student of Isthmian problems, that every solution Mr. Bates has presented is feasible and practical.

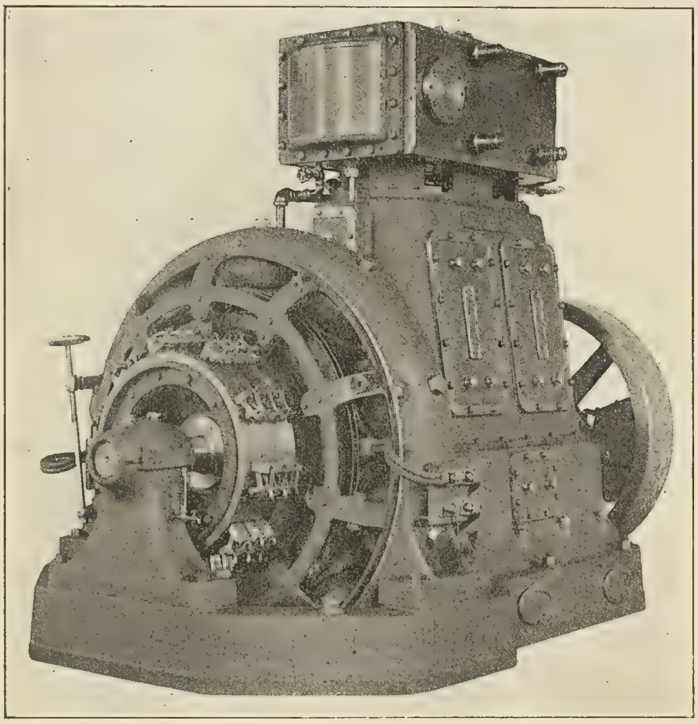
Owing to the elimination in all of 114 degrees from the canal curvature, the cutting off of nearly three miles in length, the high speed of its lake navigation, and the fact that no time is lost at his locks, Mr. Bates is able to show a reduction of five hours, or nearly 50 percent, in the time of passing through his canal, over the time demanded by every other. Owing to the diminution of unit price made possible by the terminal lake methods of operation and the deduction of some 18 or 26 miles of construction, this canal can be brought within the $145,000,000 appropriation. For the same general reasons it can be completed in eight years instead of in the 10 to 20 years demanded by the other schemes.



ENGINEERING SPECIALTIES.

A New Marine Generating Set.

The generating set which we illustrate herewith is being built by the B. F. Sturtevant Company, of Hyde Park, Mass., in five sizes ranging from 17 1-2 to 100 Kw., the latter being designed to operate at 350 revolutions per minute under a steam pressure of 150 pounds per square inch. The total weight of this set is 22,000 pounds. The motive power consists of a cross-compound



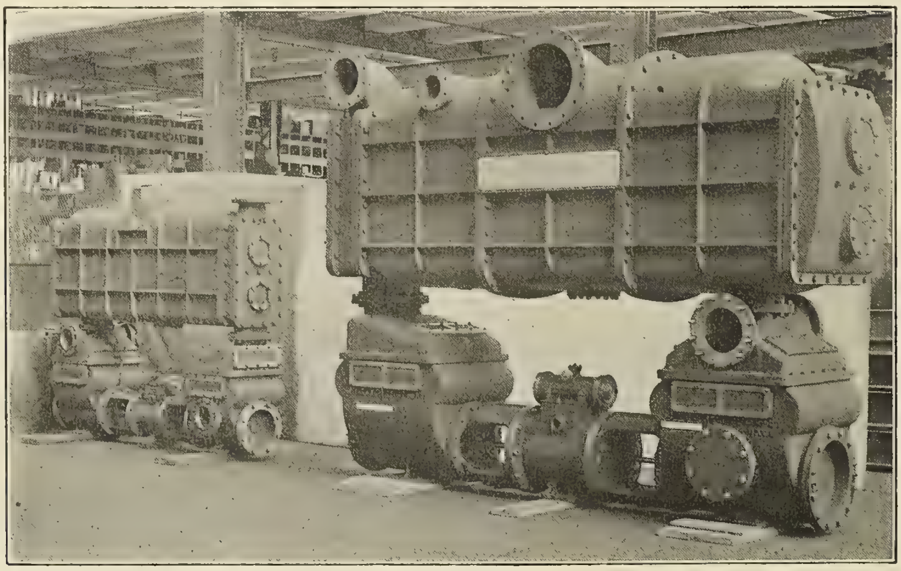
engine, with cylinders measuring 10 and 18 inches in diameter, and a stroke of 10 inches, and operating on a steam pressure of 150 pounds per square inch. The steam and exhaust pipes measure respectively 4 and 6 inches, the crank shaft has a diameter of 5 1-2 inches, and the crank pin 5 1-2 inches by 6 1-2 inches long. The multipolar generator has been designed so that it will be capable of carrying for short spaces of time as much as 50 percent overload, while it is to be capable of operating for long periods at 25 percent overload, without undue heating. It is, moreover, so designed that the jump in the voltage when full load is suddenly thrown on or off shall not exceed 15 percent. The Rites governor is expected to hold the speed within 1 1-2 percent of normal when full load is thrown on or off.

The smaller sizes have capacities respectively of 17.5, 25, 35, and 50 Kw.; their weights complete being 5,000, 7,300, 10,000, and 14,000 pounds. The cylinder dimensions are: 6 1-4 and 10 1-2 by 6 1-4; 7 and 12 by 7; 8 and 14 by 8; and 8 and 14 by 8; the steam pressure in the last case being 150 pounds, and in the other cases 100 pounds per square inch. Although originally designed and built for the United States Navy Department, they are now being turned out for the general trade and are constructed and tested in as thorough a manner as when built under government orders.

A New Surface Condenser.

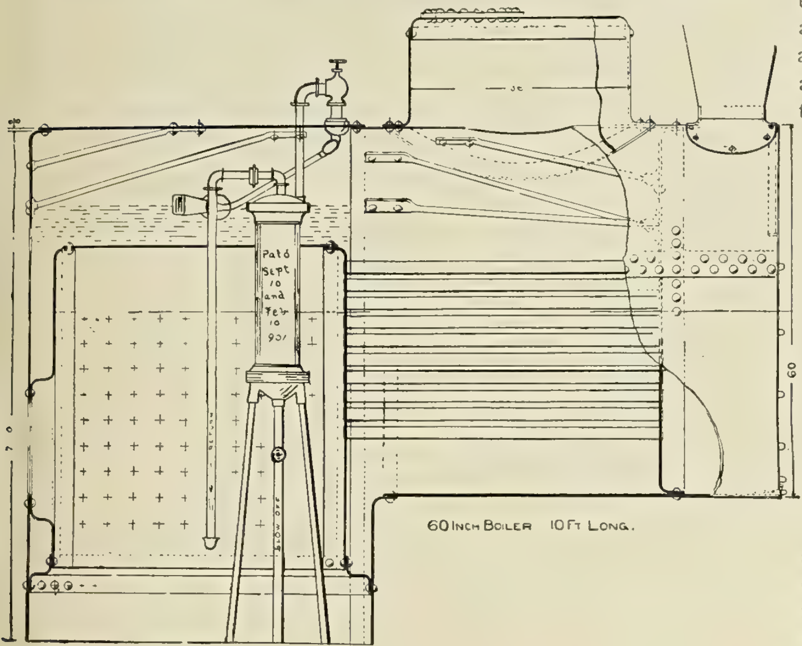
Placed on the market by the W. H. Blake Steam Pump Company, of Hyde Park, Mass., the two condensers shown in the illustration, and intended for marine use, have tubes of Muntz metal held in the tube sheets in such a manner as to allow free expansion. The steam enters at the top, and rapid condensation is secured by a liberal supply of baffle plates which force the steam into close contact with the exterior of all the pipes through which the cooling water flows. The pump of the large condenser illustrated has a 16-inch steam cylinder, 18-inch water cylinder, and 18-inch air cylinder, with a common stroke of 18 inches, the capacity being 25,000 pounds of steam per hour with 2,000 square feet of condensing surface. The suction and discharge openings in the air cylinder measure respectively 12 and 10 inches and in the circulating cylinder 12 inches. The small condenser has cylinders measuring 8 inches for steam and 12 for air and water, with a 12-inch stroke. With 450 square feet of condensing surface, the capacity is rated at 14,400 pounds of steam per hour, suction and discharge pipes being 8 and 6 inches for air and 8 inches for water.

Absolute certainty of action is insured, for the valve mechanism is actuated solely by direct boiler pressure, and is not dependent upon an adjustable arrangement of levers and rods connected to the piston. With the latter arrangement, which is not employed upon the pumps, there are certain points in the stroke where the valves are not directly controlled, but momentum is relied upon to reverse the valve gear. These pumps are composition fitted throughout, both the water and air cylinders are lined, and a Tobin bronze piston rod is used.



Buckeye Boiler Skimmer.

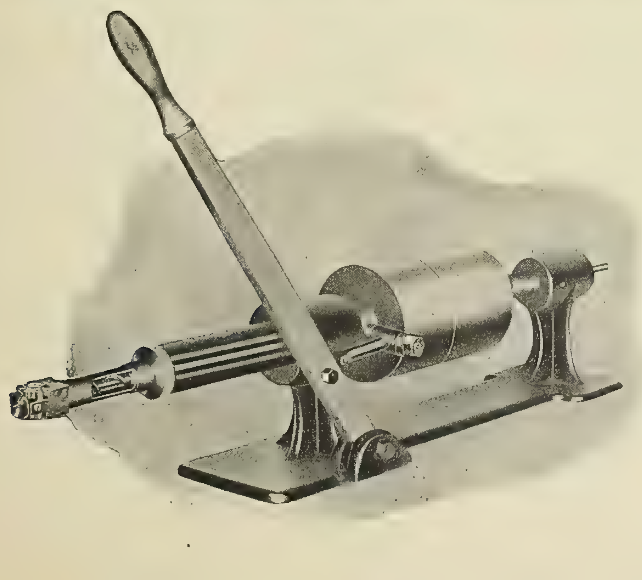
The illustration shows one of these skimmers in position on a horizontal tubular boiler. It may be said in general that the skimmer consists of a wide-mouthed funnel suspended by means of a tubular arm and floated at the surface of the water in the boiler by means of two copper floats tested to a pressure of 500 pounds per square inch, and guaranteed against either collapsing or leakage. This skimmer is stated to be especially adapted to use in very dirty or muddy water, such as is found on many of our Western rivers, and is guaranteed to keep a boiler



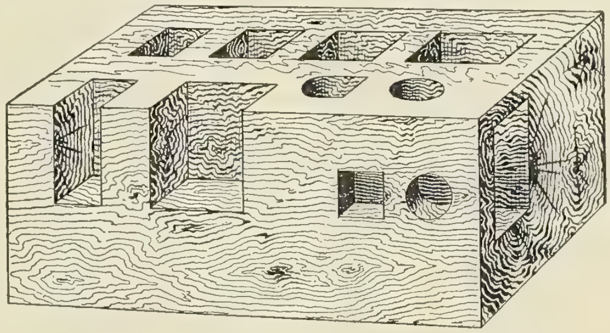
absolutely clean from such impurities when properly installed and operated. At the upper end of the arm is a flexible joint, which is both water-tight, and of such ease of operation that the floats may readily maintain the elevation of funnel desired. This implement is placed on the market by the Buckeye Boiler Skimmer Company, of Toledo, Ohio.

A New Square Auger.

An extremely interesting device, in the shape of an auger for boring square holes, is being placed upon the market by the American Pressed Steel Company, of Philadelphia. This tool should be a great labor-saving device for shipyard use on account of the rapidity with which it bores or cuts a mortise. Much time is very often lost in a shipyard in squaring out the holes for countersinking square-headed bolts, by hand, in the timber for ceiling battens or in hatch covers; and the cost of a machine and bit might easily be saved on one job. One of the machines has cut a mortise in knotty maple, one inch wide, four inches deep, and six inches long, in forty-five seconds. This mortise did not require trimming at all, the corners were accurately and cleanly cut, and although the auger was run at a high speed there was not the slightest tendency to split the wood or overheat the bit.



Although the manufacturers make this auger to fit any boring machine, for exceptionally rapid production of work they recommend their special mortising machine. All points of friction are lubricated continually through a protected channel, thus enabling the bit to be run very rapidly. Another feature in this machine is an arrangement by which the bit can be set to cut at any desired angle on the timber, or endwise of the grain. The machine is portable, as it weighs only about seventy pounds, and can be set up on a trestle or bolted to a bench. The various cutting parts of the

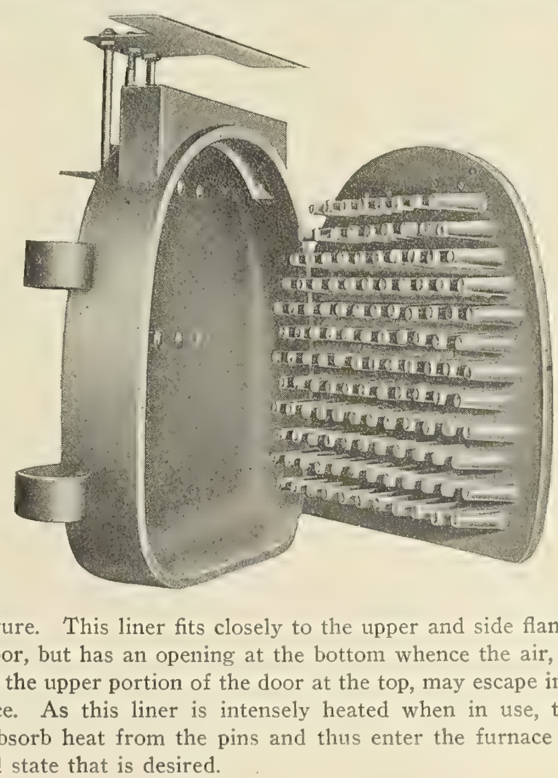


EXAMPLES OF THE WORK OF THE PEARL SQUARE AUGER.

square auger can be renewed, and are interchangeable. They are easily sharpened, and are made of the best quality tool steel. It is claimed for this tool that it is the only auger that makes a square hole or mortise with a rotary motion and bores out the wood at the same operation, leaving clean-cut corners; the only tool with which it is possible to make a mortise at any desired angle on the timber, or endwise of the grain; and the only auger which will cut any kind of a knot without injury.

Hot-Blast Furnace Door.

In order to facilitate perfect combustion at a time when a fire is apt to smoke badly, that is, immediately after stoking, it is found advisable to admit hot air for a short time within the grate, in order to ignite the escaping unconsumed carbon. To meet this requirement, the James Reilly Repair & Supply Company, 230 West street, New York city, has produced a furnace-door liner having a large number of pins cast on the inner face, as shown in



the figure. This liner fits closely to the upper and side flanges of the door, but has an opening at the bottom whence the air, which enters the upper portion of the door at the top, may escape into the furnace. As this liner is intensely heated when in use, the air will absorb heat from the pins and thus enter the furnace in the heated state that is desired.

TECHNICAL PUBLICATIONS.

Business Features of Engineering Practice. By Alex. C. Humphreys, M.E., ScD., LL.D., President of the Stevens Institute of Technology. Pages 187. Hoboken: Published by Stevens Institute of Technology, 1905.

This very sparsely covered field of engineering practice has received a notable addition in the present work by President Humphreys. The importance of the subject should co-operate with the paucity of information to be found in print, in making the work exceedingly valuable. It consists in a series of excellent lectures before the institute delivered by President Humphreys and others, and covers a wide range of subjects coming under the general head indicated by the title.

Gas Engines and Producer-Gas Plants. By R. E. Mathot, M.E. Translated by W. B. Kaempffert, with a preface by Dugald Clerk. Pages 314 + 9; illustrations 152. New York: Norman W. Henley Publishing Company, 1905. Price $2.50.

This book covers a field which is as yet in part almost untrodden, and as a pioneer in the subject ought to have a great influence upon the development of the producer-gas outfits, which are now beginning to attract so much attention among engineers. It is an essentially unmathematical descriptive treatise of gas engines and gas producers, splendidly illustrated with diagrams of different types of machines and appliances, and intended as an operating guide for both designers and users in the construction and operation of both producer plants and gas engines. Valuable suggestions are given regarding the purchase of an engine, its installation, and questions and problems arising in connection with its care and operation.

Experimental Researches on the Flow of Steam Through Nozzles and Orifices. By A. Rateau. Translated by H. Boyd Brydon. New York: D. Van Nostrand Company, 1905. Price $1.50, net.

This little book consists of 76 pages of reading matter and is illustrated with four figures in the text and four folding plates illustrating the apparatus and curves of results from which the conclusions were drawn. The experiments were made at the time that Professor Rateau was engaged in the studies which finally resulted in the steam turbine bearing his name. They relate to the fundamental problem of steam turbine design, involving the proportions of nozzles and passages; and while distinctly a problem in physics, with all the care and precision which that implies, they were at the same time based upon an appreciation of practical considerations with regard to construction and operation. The importance of the book to the designers and builders of steam turbines can scarcely be overestimated.

Alternating Current Machinery. By William Esty, S.B., M.A., Lehigh University. Pages 412; figures 380. Published by the American School of Correspondence, Chicago, 1905. Bound in half-morocco. Price $3.75.

This book was written for the express use of practical men whose knowledge of mathematics extends no further than through the elementary principles of geometry and trigonometry; for this reason great pains have been taken to give great simplicity and clearness to all descriptions, explanations, and proofs. Graphical or geometric methods have been adopted wherever possible as giving a ready and easily understood explanation of various phases of electrical phenomena. The first 200 pages of the book are devoted to a description of various types of alternating machinery, together with measuring instruments for recording their operation. This part of the work is immediately followed by descriptions of synchronous motors, transformers, rotary converters and induction motors, together with chapters on switchboard and station appliances and apparatus. The illustrations are clear and well designed, and are of great value in following the text, while a good index at the rear of the volume places the work in the category of a handbook.

The Automobile Pocketbook. By E. W. Roberts, M.E. Pages 329; diagrams and illustrations 51. Bound in limp leather, 3 1-2 by 5 1-4 inches. Cincinnati, Ohio: The Gas Engine Publishing Company, 1905. Price $1.50, postpaid.

Designed to give clear and concise information on the general subjects of the operation and care of an automobile, this little book tells what to do in the case of an emergency, and, at the same time, includes a great deal of information on the subject of design of the various parts. In the interest of conciseness all reference to the historical side of the subject has been entirely omitted, and the book as a whole is intended to cover just exactly the points required by the user or designer of the machine, without any extraneous matter. It fits very handily in the pocket, and ought to find a ready field among all interested in the subject.

Gas Engine Design. By Charles E. Lucke, Ph.D. Pages 254 + 66; figures 145. New York: D. Van Nostrand Company, 1905. Price $3.00, net.

The purpose of this book being to present in a compact form the general principles underlying the design of gas engines, together with data taken from reliable sources and applicable to the use of those engaged in the design and construction of this popular form of prime mover, the inventive side of the design, which is treated at great length in nearly every previous work on the subject, has been entirely omitted, it being assumed that the reader is quite familiar with it. This leaves for this book simply the quantitative side of the design, with a discussion of the forces acting among the various parts, and the designs of the parts for the double purpose of transforming those forces into useful work, and of resisting their tendency to disrupt the elements of the engine. The work is divided into three parts, of which the first treats of power, efficiency and economy, the second of the forces in the engine due to the pressures of the gases and to inertia, and the third, which comprises nearly one-half of the book, to the dimensions of the engine parts. The higher mathematics have not been shunned in the treatment of the subject, though whenever it has been possible to obtain a simpler form of treatment this has been done. Illustrations of the various curves of inertia and effort diagrams are plentifully supplied, and add greatly to the character of the work. Figures and typography are excellent.

Text Book of Naval Engines and Machinery. By John K. Barton, Commander, United States Navy. Pages 581; figures, 248. Annapolis, The United States Naval Institute, 1904.

This work consists of two volumes, the first being the text and the second a volume of plates, 35 in number. It is intended as a text book for the use of students in the United States Naval Academy at Annapolis, where there is required only a sound general knowledge of such parts of the engineering field as are of special and practical use to the naval engineer, supplemented by a considerable amount of practical work in the engineering shops and in the management and care of the engines and boilers of the various torpedo craft, monitors, and steam launches available at that station. No mention has been made of the design of steam machinery, the particular function of the book being the construction, operation, management, and care of such machinery as is found on naval vessels. The work starts from a basis of definitions of work, energy, power, etc., traces the action of steam under varying conditions, and after a more or less extensive description of the various component elements of steam engines and other naval machinery, goes into the question of the indicator and its uses, curves of crank effort, and the subjects of propulsion and screw propellers. Considerable attention is paid to the question of engine balancing, as well as to that of the steam turbine. An appendix is added, giving naval regulations for the care of engines and boilers, together with tables of logarithms, mean pressures and the properties of saturated steam.

The book of plates includes drawings of the main engines of the armored cruisers *Washington* and *Tennessee,* together with outlines of a large number of parts, and some drawings of refrigeration and turbine installations, as well as a section of the Curtis turbine.

Marine Engines and Boilers; Their Design and Construction. A handbook for the use of students, engineers, and naval constructors. Edited by Leslie S. Robertson. Pages 744; figures 535. New York: Norman W. Henley Publishing Company, 1905. Price $9.00 net.

This handbook is based upon the excellent work in German of Dr. G. Bauer, engineer-in-chief of the Vulcan Works at Stettin, and has been translated from the second edition by E. M. & S. B. Donkin. Part I is devoted to the main engines, and is subdivided into sections upon the determination of cylinder dimensions, the utilization of steam in the engine, a discussion upon turning moment and balancing, the general arrangement of main engines, and details of main engines. Part II is devoted to the innumerable pumps used for various purposes on shipboard, including air pumps, circulating, feed, and auxiliary pumps, operated both independently and by direct drive from the main engine. Part III is devoted to shafting, resistance of ships and propellers, in the latter item going into both design and construction. Part IV is devoted to pipes and connections. Part V treats of steam boilers, and is divided into sections upon the generation of steam, cylindrical, locomotive, and water-tube boilers, funnels and lagging, forced draft, and boiler fittings and mountings. Parts VI and VII give a large amount of information upon measuring instruments and various details for the engine room and boiler room. About 80 pages in Part VIII are devoted to an extensive collection of the various mathematical tables usually found in works of this sort, while the book concludes with an appendix upon the Admiralty report on naval boilers in the British navy, and a very complete index.

The illustrations are unusually complete and splendidly chosen, many of them consisting of folders, giving both half-tones and line engravings of various engines of considerable note; and the information given in general being taken from actual cases of splendid construction, and referred to the cases specifically, ought to be of immense value to any one using the book. In this connection, we might mention an extended table giving particulars of cylinder sizes and ratios and general constructional features upon a large number of ships of various types, running from torpedo boats and destroyers up to the largest class of warships and transatlantic liners.

QUERIES AND ANSWERS.

All reasonable questions concerning marine engineering received from and signed by subscribers will be answered by the Editor in this column. All communications must bear the name and address of the writer.

Q. 290.—We would be pleased to have you answer in your notes and questions column what is considered the best practice in balancing a four-crank triple expansion engine, and at what angles the cranks are usually placed. S. M. C.

A.—This is a very complex subject, and one to which there is no definite answer unless the exact details of the particular case in hand are known. We find, however, an example given in the 1904 edition of Seaton's *Manual of Marine Engineering* for a four-cylinder triple expansion engine, having cylinders 23 1-2 inch, 38 inch, 43 inch and 43 inch, with a stroke of 36 inches. The arrangement of these cylinders is, low pressure, high, intermediate, and low, beginning at the forward end. The sequence of the cranks is high-pressure, after low-pressure, forward low-pressure, intermediate pressure, and again high-pressure. The engine is balanced on the Yarrow-Schlick-Tweedy system, and from the diagram we estimate the angles to be as follows: From high-pressure to after low-pressure, 77 degrees; to forward low pressure, 96 degrees; to intermediate pressure, 77 degrees; and back to high-pressure, 110 degrees.

Q. 291.—Can you tell me the process through which the large calibre and other guns are finished; that is, how they obtain the polished brown with which they are finished? M. W.

A.—The Bureau of Ordnance of the Navy Department has furnished us with the following information and formula regarding the process of putting a finish on heavy guns in the naval gun factory:

Solution: 6 drops of tincture of iodine,
2 ounces of corrosive sublimate,
4 drachms spirits of nitre,
1 " tincture of steel,
1 " nitric acid, C. P.,
4 1-2 pints of pure water.

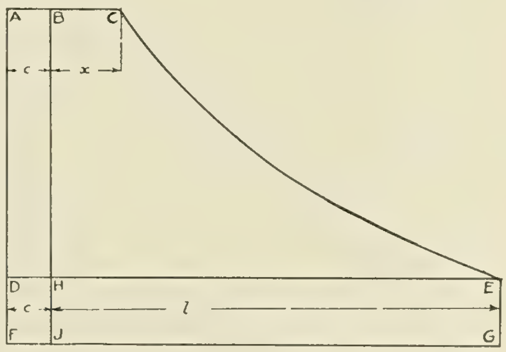
The guns must be made perfectly clean and free from grease by washing with a strong solution of potash, then washed with clean water, and wiped dry. Then apply the above solution with a soft, clean sponge. Let the solution remain on the gun for five or six hours until a dry coat of rust is formed. Then scratch brush the gun until the rust is scratched off; afterward wipe well with muslin cloth. Subsequently immerse the gun in a tank of boiling water and let it remain for about thirty minutes—the water to be kept boiling all the time that the gun is in it. After this the gun is allowed to cool until cool enough to bear your hand on it without discomfort.

This process is to be repeated until the gun has had at least five coats on it—sometimes it requires six coats—which is a matter of judgment. After the gun has had the required number of coats, rub well with the muslin cloth and apply a light coat of sperm oil with a flannel cloth.

It is best to use a circular wire brush attached to a flexible shaft, but it may be done with the ordinary file card held in the hand.

Q. 292.—Please answer this question and oblige. With steam at 60 pounds pressure, what would be the point of cut-off to expand down to atmospheric pressure? W. M. F.

A.—As this query does not give any information regarding the clearance of the engine in question we have assumed this to be 10 percent. Referring to the diagram, the clearance is represented by the distance *AB*, which we have designated *c*. The point of cut-off is *C*, and the percentage of stroke covered up to that point we have represented by *x*, the entire length of the stroke being *l*. Assuming that this steam is expanded adiabatically from a pressure at *C* of 60 pounds per square inch gauge to a pressure at *E*



equal to atmospheric pressure, or 14.7 pounds absolute per square inch, we find that the percentage of stroke covered up to *C* is about 15 1-2, which is obtained as follows:

Calling volume at point of cut-off $= v_c = c + x = 0.1 + x$, volume at end of stroke $= v_E = c + l = 1.1$, and pressures respectively p_c and p_E, and knowing that $pv^{\frac{10}{9}}$ is a constant for adiabatic expansion, we equate the value of pv at *E*, where both quantities are known, to that at *C*, where only the value of p is known. This gives us at once the value of v at *C*, thus:

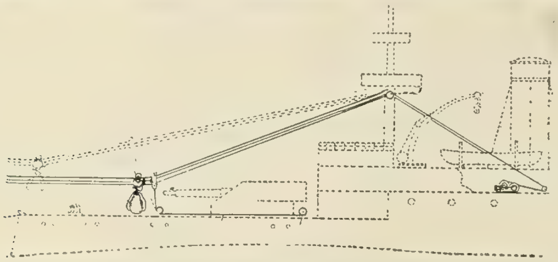
$$p_C v_C^{\frac{10}{9}} = p_E v_E^{\frac{10}{9}}, \text{ whence } v_C = v_E \times \left(\frac{p_E}{p_C}\right)^{\frac{9}{10}}$$
$$= 1.1 \times \left(\frac{14.7}{60 + 14.7}\right)^{\frac{9}{10}}$$
$$= 0.25465.$$

This gives $x = 0.15465$, or 15.465 percent.

SELECTED MARINE PATENTS.

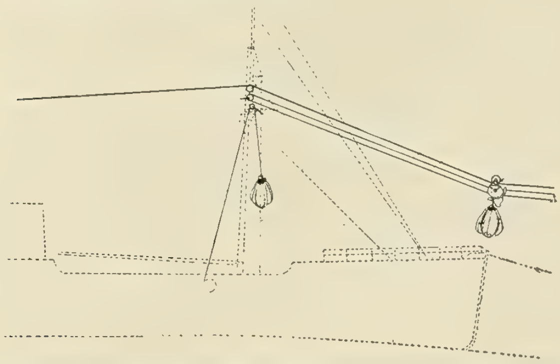
786,510. CONVEYING APPARATUS. THOMAS S. MILLER, SOUTH ORANGE, N. J.

Claim.—1. In combination, a supply-ship, a consuming-ship, a transit-rope connecting the two, a load-carriage, a forward transit-actuator on said consuming-ship and a backward transit-actuator exterior to said supply-ship.



2. In combination, a supply-ship, a consuming-ship, a transit-rope connecting the two, a forward transit-actuator and a backward transit-actuator, both said actuators being on said consuming-ship.

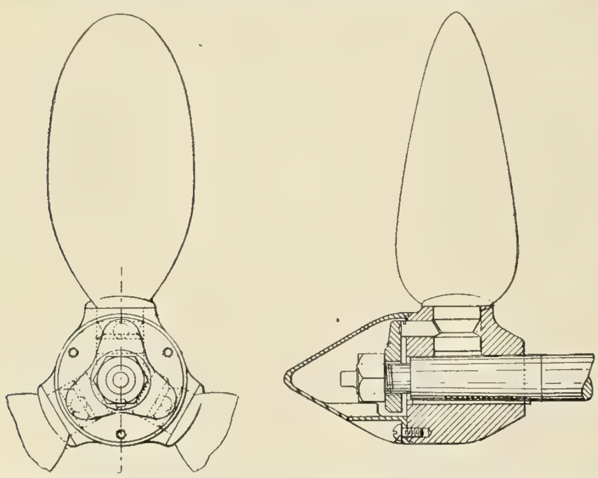
3. In combination, a supply-ship, a consuming-ship, a transit-rope connecting the two, a load-carrier, a supporting-rope, forward and backward transit-actuators and a supporting-rope tension-actuator; all of said actuators being exterior to said supply-ship.



5. In combination, a supply-ship, a consuming-ship, a ropeway connecting them, a load-carriage, a rope-drum mechanism on the consuming-ship and a sea-anchor participating in the control of the load during transit. Thirty-one claims.

787,084. APPARATUS FOR THE PROPULSION OF SHIPS. WM. T. DONNELLY, BROOKLYN, N. Y.

Claim.—4. A propelling device for ships comprising a rotatable shaft, a hub provided with sockets for blades mounted thereon, detachable blades mounted in said sockets, locking-pins adapted to secure said blades, a washer mounted upon the propeller-shaft, a tail-nut acting to force all parts axially along the propeller-shaft, and a cap or shield covering the tail-nut, secured to the hub and provided internally with projections which prevent the turning of the tail-nut while the cap is in place.



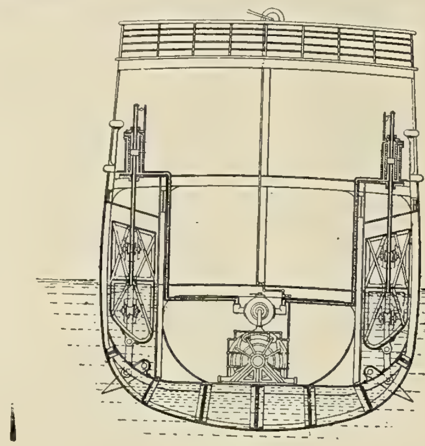
7. A propelling device for ships comprising a rotatable shaft, a hub provided with sockets for blades mounted thereon, detachable axially-adjustable blades mounted in said sockets, locking-pins, a tail-nut forcing the propeller axially upon the shaft, and means for securing the blades in their sockets by the axial thrust of the tail-nut along the shaft which presses the locking-pins inward. Seven claims.

787,811. FLOATING CURRENT-WHEEL. PHINEAS M. WARREN, NYSSA, ORE., ASSIGNOR OF ONE-HALF TO THOMAS J. HUFF, NYSSA, ORE.

Claim.—1. A floating current-wheel consisting of an axial shaft, a series of buoyant hollow buckets arranged parallel to the said shaft in circular series around the shaft and removed from the same, a circular brace connecting the buckets, and a series of radial hollow spokes communicating at their outer ends with the inner edges of the buckets and at their inner ends being connected with the central shaft and having openings as described whereby the hollow spokes form an integral part of the wheel and also act as drainage-tubes. Two claims.

787,182. WAVE-MOTOR. JOHN HUTCHINGS, LONDON, ENGLAND.

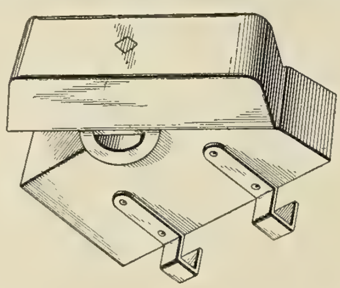
Claim.—6. In apparatus for forcing fluids a floating vessel—such as a ship—chambers therein accessible to the sustaining body of water and to the atmosphere, floats buoyed upon said water, chambers in said floats respectively imprisoning air and water therein, means of communication between



said water-chamber and the atmosphere and means for conveying the relative reciprocatory motions of the floating vessel and its contained floats to pistons and cylinders respectively connected thereto, pipes for conveying and valves for controlling the flow of the fluid being forced through said pipes to any suitable means for utilizing the same as motive power. Six claims.

787,294. BILGE-BLOCK. JOHN HICKLER, PASADENA, CAL.

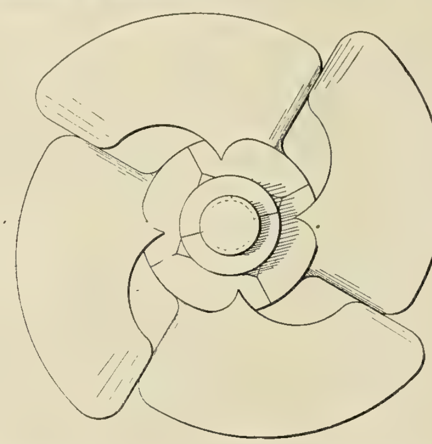
Claim.—The herein-described bilge-block consisting of a tilting member having a plane upper and lower face, a hollow semi-circular bearing-plate having end flanges, a plane upper surface, a semi-circular bearing-surface, said bearing-plate being secured to the tilting member by means of a bolt



passing through said block and through the plane upper wall of the bearing-plate, and a bearing member having a semi-circular recess therein to form a seat for the bearing-plate, the flanges at the ends of the bearing-plate serving to prevent sidewise movement of the tilting member. One claim.

787,745. PROPELLER. CALVIN T. FRIED, WEST ORANGE, N. J., ASSIGNOR TO FRIED ENGINEERING COMPANY, A CORPORATION OF NEW JERSEY.

Claim.—3. A propeller comprising a number of propeller-blades, each blade consisting of a face, representing the thrust area of the blade, and an outer marginal and curved edge on each blade, said edge being part of an increased spiral starting at the center of the propeller and said spiral representing the line of centrifugal force created due to the mass of the element upon which the blades act during their advance upon the same whereby said blades utilize the power expended in the creation of the aforesaid centrifugal force, by increasing the thrust parallel to the central axis of the propeller in like ratio.



14. The combination, with a propeller-shaft having a thrust-receiving shoulder, and a series of dovetail grooves, each dovetail groove extending in the direction of the central axis of the shaft and each dovetail groove having its central axis located at one side of said central axis of the shaft, to provide an arrangement of dovetail grooves eccentric with the said shaft, said shaft being provided with an annular groove and an annular shoulder, of a series of separately-constructed propeller-blades, a hub member at the root of each blade, a dovetail connected with each member registering with a dovetail groove, and a retaining-collar in said annular groove, comprising a pair of half-sections, and bolts for securing said half-sections together. Fourteen claims.

Marine Engineering

JULY, 1905.

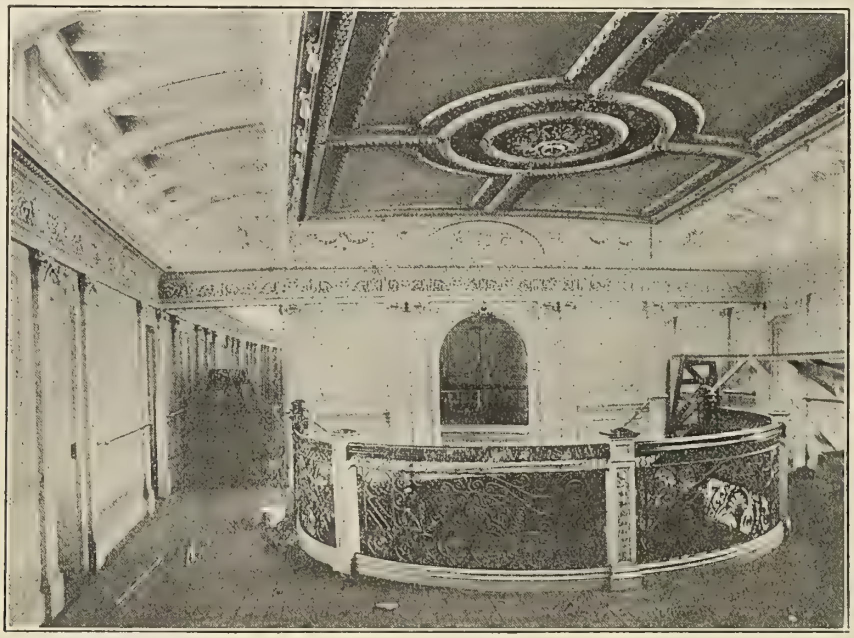
THE FALL RIVER LINE STEAMER PROVIDENCE.

Built for service between New York and Fall River in connection with her sister ships *Priscilla, Puritan, Plymouth,* and *Pilgrim,* the *Providence* is the fourth of that name owned by the Old Colony Steamboat Company, and is just about to be placed in service. The first *Providence* was built in 1832, and had a measurement of 400 tons; the second boat of the name was placed on the route between New York and Providence in 1865, and was of 900 tons measurement; the third, which was for many years the most famous steamer of her class in the world, was launched in 1866, and had a length of 373 feet. She was broken up in 1901. The new ship is not the largest in the Fall River Line, but she is by far the most luxuriously fitted, as is evidenced by the fact that her cost has been more than $1,300,000. She has a length over all of 397 feet, a length on the water-line of 378 feet 6 inches, a breadth of hull of 50 feet, and a total breadth over the guards of 88 feet, while the depth of the hull is 21 feet 10 inches and the draft of water 12 feet. Her registered gross tonnage is 4,365.

The *Providence* is licensed to carry 1,200 passengers, and has sleeping accommodations for that number. She has in addition a considerable freight capacity, it being estimated that she can carry 900 tons on her normal draft. The staterooms are distributed as follows: On grand saloon deck, 161; galley saloon deck, 152; and dome deck, 33; making a total of 346, all beautifully decorated and very attractively furnished. At the extreme aft of the gallery saloon is located a music room; forward of this is the social hall. The dining room is at the after end of the lower saloon and is fitted entirely with small tables seating four persons each. Each table holds an electric candelabra, adding considerably to the effect of the room. A private dining room opening from the forward part of the main dining room is handsomely paneled in teak.

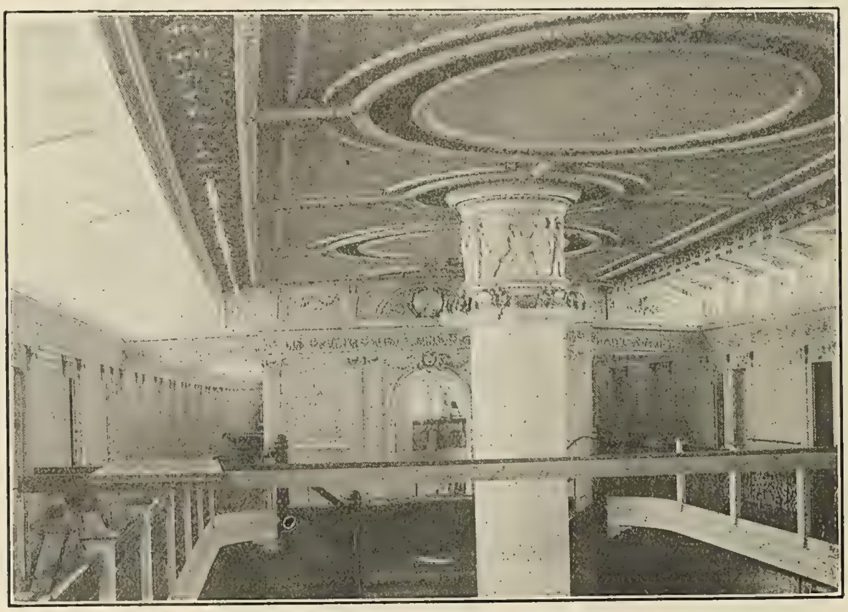
THE NEW SOUND STEAMER PROVIDENCE.

The hull is constructed of mild steel with double bottom for the greater part of the length, the appearance being of the familiar sound type of steamer, with a straight stem and semi-elliptical stern, and sponsoned wing walls from the paddlewheels tapering gradually forward and aft and adding considerably to the strength of the ship, as well as securing a great range of stability. The three tiers of deck houses are erected over the main deck and are surmounted by two funnels, and the usual flagpoles. The double hull is sub-divided into thirty-eight separate watertight compartments, protecting the vessel against danger from the effects of grounding, and localizing to a very restricted area any damage which might result. In addition to these cellular sub-divisions the hull itself is divided by transverse steel bulkheads into eight watertight compartments, the bulkheads being of sufficient strength to sustain the pressure of water in case any one of the compartments should be filled.



HEAD OF STAIRWAY IN SOCIAL HALL.

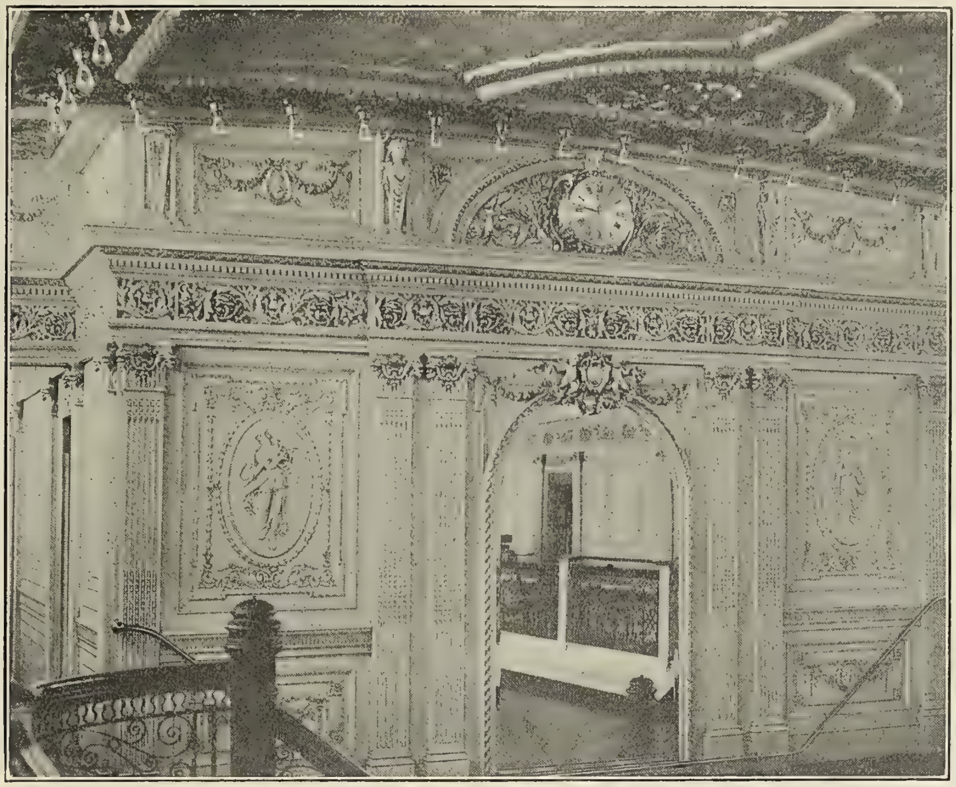
The vessel has a total of seven decks, known respectively as lower, main, saloon, gallery, hurricane, break, and dome. Below the main deck the construction is entirely of steel, but above this point the construction is of wood on a steel frame work. This method of composite construction gives an exceptionally light structure, while retaining the necessary rigidity.



THE CAPITAL AND CEILING DECORATIONS.

The *Providence* is propelled by iron feathering paddlewheels with an outside diameter of 29 feet 6 inches, each containing twelve buckets 13 feet long and 4 feet wide. These wheels are actuated by double inclined compound engines, the two high-pressure cylinders having a diameter of 44 inches and low-pressure 83 inches, this giving a ratio of piston area of 3.55 to 1; the stroke is 9 feet. The framework of the engine is built up of heavy steel plates secured to the inner bottom and frames of the ship. Stevens valve gear is used with Stephenson link motion and Sickel cut-off. Each engine has a separate condenser with cooling surface of 5,000 square feet, the condenser shells being as usual of cast iron. The circulating water is supplied to each condenser by two 10-inch centrifugal pumps driven by independent vertical engines. The two main air pumps, each 50 inches in diameter by 30-inch stroke, are connected to the low-pressure crossheads by means of links and rocker shafts, each pump having a 16-inch suction opening from the condenser and discharging into the feed-water heater through the hot well and filter tank.

The boiler room is situated immediately forward of the engine



THE SIDE WALL DECORATIONS.

room and contains six single-end Scotch boilers arranged back to back in the center of the vessel, with fire rooms outboard extending fore-and-aft and fitted for closed ash-pit forced-draft system. These boilers have a diameter of 14 feet 9 inches and are 12 feet 9 1-2 inches long, having been designed for a working pressure of 152 pounds per square inch. Each contains three corrugated furnaces of an inside diameter of 49 inches together with 308 tubes, 3-inch outside diameter, with a thickness represented by No. 10 B.W.G. The grate surface per boiler is 88.8 square feet, while the heating surface is 2,542 square feet, giving a ratio of heating surface to grate area of 28.6 to 1. The fire rooms are equipped with four ash ejectors, two on each side; the coal bunkers run fore-and-aft and have a total capacity of 200 tons.

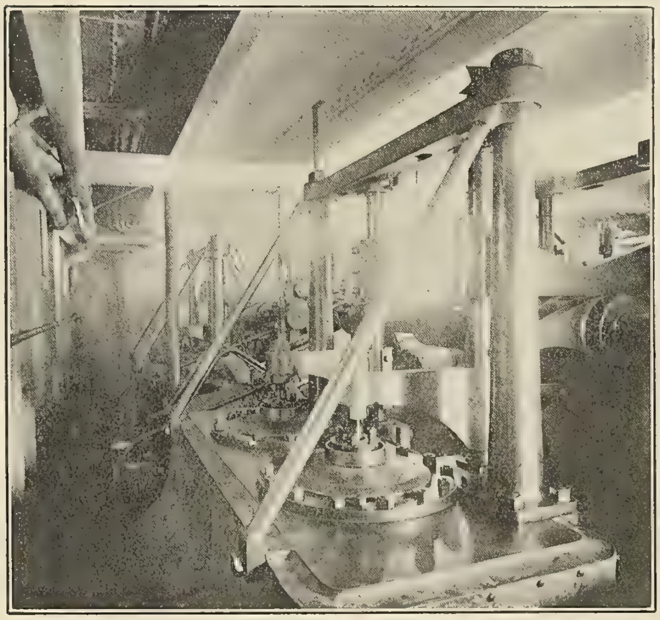
The two funnels are arranged fore-and-aft and are circular in cross section, each having an inside diameter of 7 feet 7 inches and an outside diameter of 8 feet 9 1-2 inches. The height from the grates is 90 feet 3 inches. At the base of each stack is a superheater 11 feet in diameter and 12 feet high. On the main deck just abaft the superheater is a vertical donkey boiler 83 inches in diameter, and built for a working pressure of 162 pounds per square inch; the grate area is 30 square feet and heating surface 862 square feet.

There are two 12-inch by 7-inch by 12-inch Blake horizontal duplex feed pumps, located in the engine room, and connecting with the condenser, the feed-water heater, and the forward and aft feed tanks and discharging into the feed mains. Two other pumps in the engine room are respectively a 12-inch by 9-inch by 7-inch Cameron bilge pump with a 5-inch suction from the secondary drain; and an 8-inch by 5-inch by 12-inch Blake duplex pump for fresh-water service. An additional Blake feed pump is used for the donkey boiler. In addition to the feed pumps both main and auxiliary boilers are equipped with injectors. Two other pumps are fitted in a special room and designed for fire and wrecking service. These are both of the Blake horizontal duplex pattern, one being 18 1-2-inch by 12-inch by 12-inch with a 10-inch suction from main drain, and the other 14-inch by 8 1-2-inch by 12-inch with 12-inch suction from the sea.

The general style of the interior architecture and decoration is French renaissance, strongly influenced by the period of Louis XVI, this being a most graceful character of decorative architecture in lending itself particularly well to the flowing lines of marine work. The color throughout the major portion of the

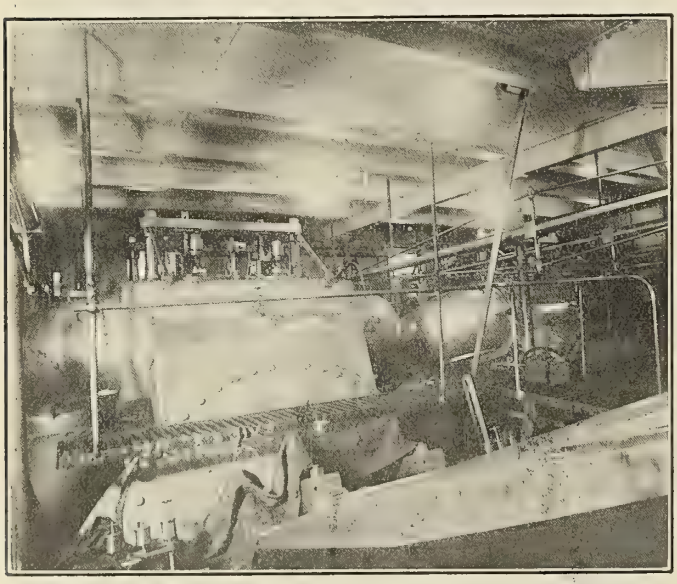
IN THE SOCIAL HALL.

steamer is of rich old ivory accentuated with gold in the prominent relief parts. The iron work of the balustrades is painted a dull black; the electric-light fixtures are of burnished gold finish, and they are so distributed that while the lighting is brilliant the general effect is a soft diffusion of light through all parts of the interior of the vessel. A total of about 1,600 incandescent lamps are used.



THE VALVE MECHANISM.

The electric light generating plant consists of three 50-Kw. General Electric direct-connected marine generating sets, operating at 350 revolutions per minute, and giving a voltage of 110. This plant is located on the main deck in the engine-room inclosure, and distribution is made on the two-wire system. The usual



IN THE ENGINE ROOM.

auxiliary machinery for steering and handling the ship has been provided, including steam- and hand-steering gear, a powerful steam windlass on main deck forward, together with steam capstans for wharfing purposes. The anchor gear consists of two 5,200-pound anchors and 180 fathoms of 1 7-8-inch chain cable with the usual cranes and rolling boards.

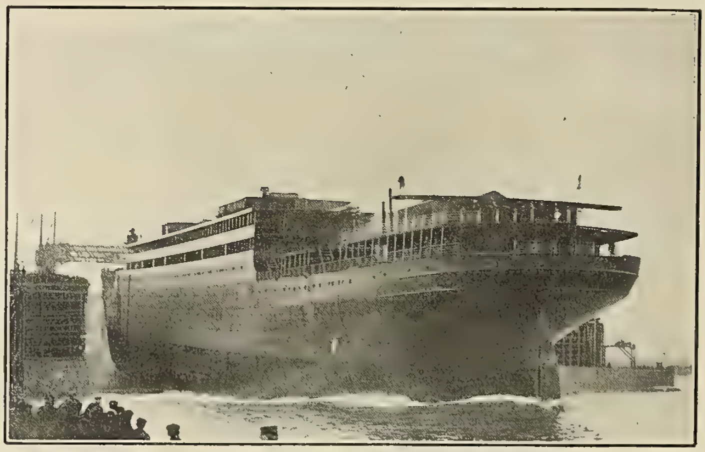
The run of the *Providence* from New York to Providence is 184 miles, which distance is covered in ten hours, although it can be done in nine hours when necessary. The engines, boilers, and all fittings, with boilers full of water, weigh 1,550 tons, and the horsepower of the machinery is about 5,500. The pressure of steam when under ordinary service is only 100 pounds per square inch, although the machinery was designed for a maximum working pressure of 152 pounds. The anticipated coal consumption is 70 tons in the run of 184 miles. This gives the ship one mile on 852 pounds of coal. It also figures out as 2.85 pounds per indicated horsepower per hour.

The life-saving equipment consists of 1,400 life preservers, 12 lifeboats, and 10 life-rafts. The lifeboats are each 26 feet 7 inches in length and 2 feet 6 inches deep; the life-rafts are 20 feet in length with cylinders 22 inches in diameter. The requirements for steel plates, angles, beams, and rivets in the hull call for 1,780 tons, the rivets used being about 700,000 in number. The lumber used in the deck houses and in interior fittings and decks was about 1,500,000 board feet. The steamer is equipped with wireless telegraphy and hence will be in communication with the shore at all points of her passage. She is also equipped with a very complete telephone system, there being one in each stateroom and a total of 375 on the boat.

The *Providence* was designed by the late Mr. George Peirce, and was built by the Fore River Shipbuilding Company, of Quincy, Mass., under the supervision of Messrs. Stevenson Taylor, consulting engineer, and J. Howland Gardner, superintendent of marine construction of the Old Colony Steamboat Company.

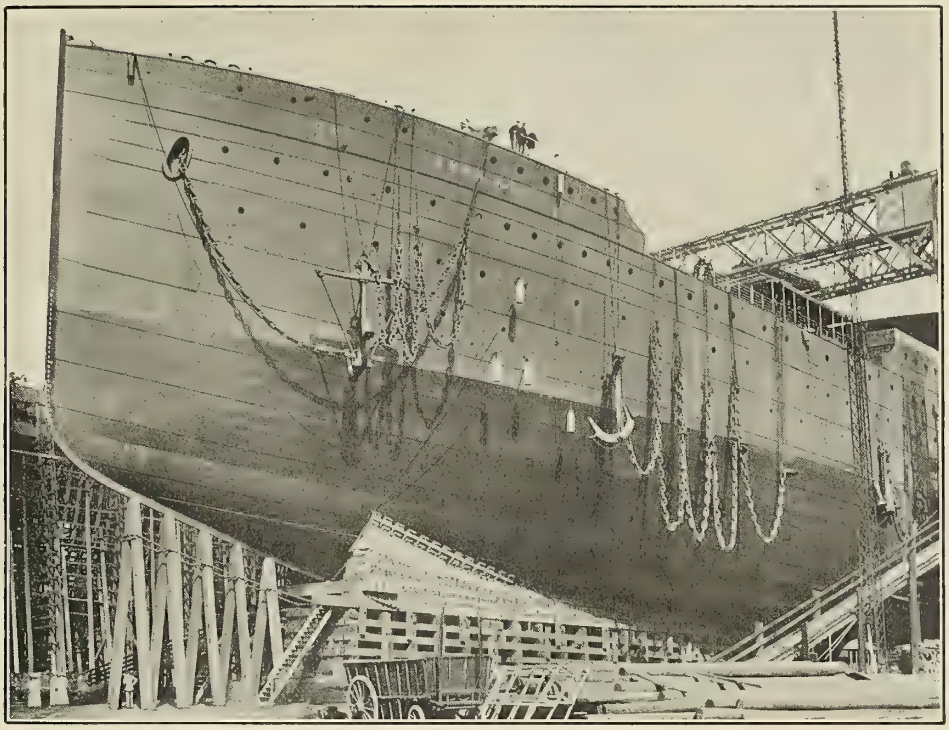
Launch of the Hamburg-American Liner Amerika.

On Thursday, April 20, Messrs. Harland & Wolff, Belfast, launched the fine large steel twin-screw passenger steamer *Amerika,* for the Hamburg-American line. The new steamer has a gross tonnage of about 22,800, and when completed will be the largest vessel afloat outside the British mercantile marine. She will be fully fitted up for a very large number of first-, second-, intermediate-, and third-class passengers, the accommodation for the higher class passengers being most elaborate and luxurious, and that for the other classes also exceptionally good. Several new features have been introduced into the vessel, the chief of which are the special restaurant, and a fine recreation room con-



THE AMERIKA TAKING THE WATER.

taining a gymnasium and other facilities for athletic exercises, which will also be much appreciated by passengers desirous of such recreation. As usual in the large vessels built by this firm, the machinery is of their quadruple-expansion balanced type, reducing vibration to a minimum, a condition to which much importance is attached. The practical immunity from vibration gained by the introduction of quadruple expansion and the balanced principle, as scientifically worked out by Harland & Wolff and practically demonstrated in the vessels already built by them, is a significant fact at the present time, as illustrating the perfection to which the reciprocating engine has been brought.



THE BOW, SHOWING THE FOREFOOT CUT AWAY.

The *Amerika* has a length of 670 feet, a beam of 74 feet, and a depth of 52 feet. The height to the boat deck is 77 feet 6 inches, the displacement 40,000 tons, and the cargo capacity 15,000 tons. The speed for which she was designed is 17.5 knots. She will carry 600 first-class, 300 second-class, 250 third-class passengers, 2,300 immigrants in the steerage, and a crew of 550. The arrangements for the comfort of the first-class passengers are most luxurious, the staterooms containing no upper berths, and some of them being as much as 10 by 17 feet in dimension.

AFTER THE LAUNCHING.

A sister ship to the *Amerika*, to be known as *Kaiserin Auguste Victoria*, is being built at Stettin, and has slightly larger dimensions, but the accommodations are almost identical. The *Kaiserin Auguste Victoria* has a length of 705 feet, the very unusual beam of 77 feet, and a depth of 53 feet 9 inches. Her displacement is 40,000 tons and cargo capacity 16,000 tons, the gross tonnage being about 25,000. These two ships have caused some comment on account of the fact that they are to be equipped with passenger elevators. They will have two funnels and four masts.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, report under date of June 10, 1905, the following percentage of completion of vessels building for the United States Navy:

			May 1.	June 1.
BATTLESHIPS.				
Virginia	19 knots.	Newport News Co.	85.53	87.38
Nebraska	19 "	Moran Brothers Co.	70.89	72.4
Georgia	19 "	Bath Iron Works	77.78	80.01
New Jersey	19 "	Fore River Shipbuilding Co.	81.1	84.8
Rhode Island	19 "	Fore River Shipbuilding Co.	86.	87.6
Connecticut	18 "	Navy Yard, New York, N. Y.	73.56	77.73
Louisiana	18 "	Newport News Co.	74.83	77.55
Vermont	18 "	Fore River Shipbuilding Co.	47.2	51.1
Kansas	18 "	New York Shipbuilding Co.	51.4	54.
Minnesota	18 "	Newport News Co.	63.18	65.42
Mississippi	17 "	Wm. Cramp and Sons	27.04	29.09
Idaho	17 "	Wm. Cramp and Sons	24.93	27.18
New Hampshire	18 "	New York Shipbuilding Co.	3.2	7.2
ARMORED CRUISERS.				
California	22 knots.	Union Iron Works	75.	76.2
South Dakota	22 "	Union Iron Works	72.9	74.
Tennessee	22 "	William Cramp and Sons	71.8	75.73
Washington	22 "	New York Shipbuilding Co.	74.2	76.3
North Carolina	22 "	Newport News Co	3.25	6.03
Montana	22 "	Newport News Co	3.2	5.32
SEMI-ARMORED CRUISERS.				
St. Louis	22 knots.	Neafie and Levy Co.	63.	65.3
Milwaukee	22 "	Union Iron Works	72.4	73.8
Charleston	22 "	Newport News Co.	93.78	94.88
GUNBOATS.				
Dubuque	12 knots.	Gas Engine and Power Co.	94.28	99.4
Paducah	12 "	Gas Engine and Power Co.	83.9	85.4
TRAINING SHIPS.				
Cumberland	Sails	Navy Yard, Boston	95.	95.
Intrepid	"	Navy Yard, Mare Island	97.5	97.5
TORPEDO BOATS.				
Goldsborough	30 knots.	Wolff and Zwicker	99.	99.
O'Brien	26 "	Lewis Nixon	99.	99.

MOTOR BOATS.

BY DR. WILLIAM F. DURAND.

THE PROBLEM OF THE BOAT.

Ten years ago the motor boat, or boat using some form of internal combustion engine for power, was a comparative curiosity. To-day they are commonplace on almost every harbor, lake, and water course throughout the country, from the Atlantic to the Pacific and the Great Lakes to the Gulf, while in Europe and elsewhere over the civilized world their increase in utility and popularity has been no less marked. As a line of industry collateral with the automobile and gas engine power industries, it has shared in the wonderful growth which these latter have enjoyed, and has furnished opportunity for labor and capital in amounts to suit the capacity of many moderate and small investors in lines of industrial work. A motor-boat plant is not necessarily large or expensive, nor need it absorb any very large capital. It has thus stood as one of the relatively smaller lines of industry into which many might venture with capital which would be entirely without significance in the larger lines of industrial work, and has thus played a beneficent part in aiding the moderate or small industrialist to find outlet for his capital, energy, and skill, while the product has steadily worked its way into the confidence and favor of the public until motor boats of one type or another are found literally by thousands in all parts of the country, and adapted to almost every demand of either commerce or pleasure.

In approaching a discussion of the motor-boat problem it will be well to obtain a clear idea of what may be called in its broadest terms the "Problem of the Boat." This contains the following main items:

(*a*) To design and build a floating structure which, with a certain weight of material, shall with safety be capable of carrying a certain load and admit of propulsion through the water at a certain speed.

(*b*) To design and build a motive power plant which shall serve to liberate, transform, and adapt some store of natural energy into a form available for propulsive purposes.

(*c*) To apply to the purposes of propulsion the power thus transformed, and so to realize the ultimate purpose of the combination of hull, motor, and propeller.

The important points under (*a*) are as follows:

(1) Weight of hull.

(2) Weight of additional load which may be carried.

(3) Resistance to propulsion.

(4) Safety.

(5) Cost of construction and of maintenance.

The fundamental purpose which must be held in view by the designer and builder must be to combine in the highest degree the least weight of structure with maximum capacity for additional load and least resistance to propulsion, all with due regard to safety and to the fundamental factor of all engineering work—the cost of construction and of maintenance.

The important points under (*b*) are as follows:

(1) Weight and space required for motive-power plant.

(2) Efficiency as a means of transforming energy into motive power.

(3) Simplicity, reliability, and general adaptation to the conditions and requirements of the case in hand.

(4) First cost.

(5) Cost of operation and maintenance.

The fundamental purpose here must therefore be to combine in the highest degree the utmost of efficiency as a means of transforming energy into power available for propulsion, the least weight and space required, and the utmost of simplicity, reliability, and adaptation, and all with minimum first cost and costs of operation and maintenance.

The important points under (*c*) are as follows:

(1) Efficiency as a means of utilizing for propulsion the power furnished by the power plant.

(2) Adaptation to the control of the boat, and to any special conditions or requirements which may exist.

(3) Simplicity and reliability.

The fundamental purpose here must therefore be to combine most perfectly the highest efficiency of the propulsive agent as a means of utilizing power for propulsion, with the utmost simplicity, reliability, and adaptation to the ready and sure control of the boat and to any other special conditions or requirements.

A review of these various requirements will show that the efforts toward general advancement must take the following directions:

(1) Decreased weight of hull.

(2) Increased internal space and carrying capacity.

(3) Decreased resistance.

(4) Decreased weight and space required for motive-power plant for a given power, or increased power for a given weight or space.

(5) Increased efficiency of motive-power plant as a means of transforming natural energy into motive power.

(6) Increased efficiency of propulsion.

(7) All with due regard to safety, simplicity, reliability, and the various items of cost.

It will be clear that these various requirements are mutually inconsistent in various degrees, and that no boat can contain all desirable features in the highest degree. In the general design of a boat in any given case it is therefore necessary to give to each of the various requirements and conditions a just relative weight, and then to seek for the best combination of features, having in view the especial purpose for which the boat is intended. Thus in some cases everything must be sacrificed for speed, while in others moderate speed, comfort, and safety are desired; while in others, again, economy of operation with large carrying capacity must be provided; and thus the design as a whole will take shape as the various features are combined in such manner as may best answer the special demands of the case.

It will best answer the purpose of these articles to approach the more detailed consideration of the problem through section (*b*) above, the motive-power plant, its character, design, and installation.

Remembering the fundamental requirement it is clear that the process of power development and application may be worked out in a variety of ways. In the general case the entire process may be divided into three steps or considered under three heads:

(1) The storage of energy.

(2) The liberation or manifestation of energy.

(3) The transformation of energy from the form under which it is first liberated, into mechanical work available for propulsion. In the familiar steam motive-power plant the coal or oil fuel represents the storage of energy, the boiler provides for its liberation as heat, and the engine and propeller for its transformation and utilization as propulsive work. This is the form of motive-power plant which stands preëminent with reference to the world's work of marine transportation, and it is only in small corners of the broad field, such as that with which we are to be concerned in the present series of articles, that any other form of motive power has gained acceptance.

In the naphtha launch, which represents one of the earliest forms of special motive-power boats, the energy is stored in the naphtha or other form of fuel, while it is transformed by combustion into heat, and then embodied in the naphtha vapor from whence it is transformed by the engine and propeller into the mechanical work of propulsion.

In the alco-vapor launch likewise, the energy is stored in the kerosene, gasoline, or other form of fuel, thence transformed into heat, and embodied in the alcohol vapor, and then by the engine and propeller transformed into the work of propulsion.

In the electric launch, on the other hand, the energy is stored in the cells of a storage battery, whence it is transformed into mechanical work by the motor and into work of propulsion by the propeller.

In the typical modern motor boat using the gasoline combustion engine, the energy is stored in the gasoline, this is transformed into gas and mixed with air in the carbureter, while the energy is liberated as heat in the engine cylinder, and then directly transformed into mechanical work by the engine, and into propulsive work by the propeller.

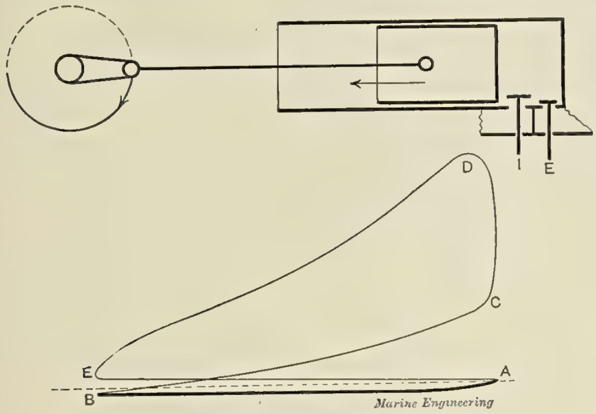


FIG. 1.—FOUR-CYCLE ENGINE, INTAKE STROKE.

In the special type known as the suction-gas engine, using coal as primary fuel, the energy is stored first in the coal and then in the gas formed in the producer. The energy is then liberated as heat in the engine cylinder, and transformed as in other types, ultimately into the work of propulsion.

These brief references to the various forms of solution for the general motive-power problem are introduced at this point simply to show the diversity of special solution which is not only possible but practicable for certain limited requirements, and to impress the relation of each to the other, and the fact that all are but special means of fulfilling certain fundamental conditions common to all problems dealing with the development and utilization of natural energy for power purposes.

THE GAS ENGINE.—PRINCIPLES OF OPERATION.

We must now turn to a more detailed examination of the gas engine and the solution which this furnishes for the general motive-power problem of boat propulsion. In the typical gas engine the main problem is as follows:

Given a hydrocarbon or other form of gas, required its combustion and the transformation into mechanical work of the heat energy thus developed.

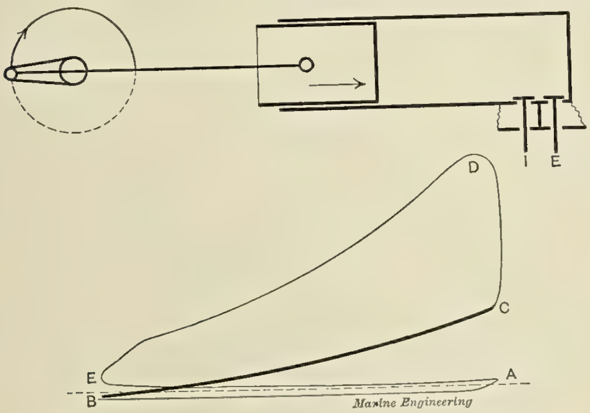


FIG. 2.—FOUR-CYCLE ENGINE, COMPRESSION STROKE.

The first step is combustion or union with oxygen. But the gas itself will not burn, and must therefore first be mixed with a suitable amount of oxygen. This is accomplished most cheaply by using air and accepting the nitrogen present simply as a diluting ingredient of the mixture. Again, it is found that such gases, even when mixed with a suitable amount of air, will not burn readily at ordinary pressures, and it is not until they are compressed to a high degree that the combustion once started will propagate itself with sufficient vigor and rapidity to render the operation practicable and useful as a factor in the cycle of a gas engine.

With this by way of introduction we may proceed with the de-

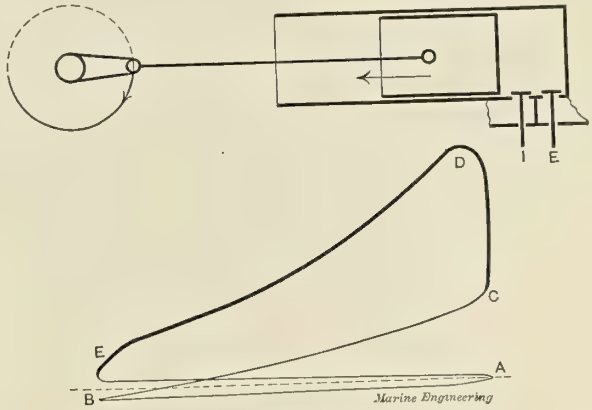


FIG. 3.—FOUR-CYCLE ENGINE, POWER STROKE.

scription of the operation of the typical or four-cycle gas engine. This type of engine receives its name from the fact that the entire cycle of operations is distributed over four strokes of the piston as follows:

(1) Intake of charge of mixed gas and air.
(2) Compression.
(3) Combustion and expansion.
(4) Exhaust.

In Fig. 1 the piston is just beginning the intake stroke, the intake valve *I* is open, and the exhaust valve is closed. The piston moves as indicated by the arrow, and at the end of the stroke the cylinder is filled with the charge. This operation is accomplished at a practically constant pressure, slightly below atmospheric pressure, and the line indicating this relation between pressure and volume is shown at *AB*, the intake line of the indicator card *ABCDE*. During the next stroke, shown in Fig. 2, the intake valve is closed and the piston returns on its path thus compressing the gas in accordance with the law of rising pressure shown by the line *BC* of the indicator card. At the close of this stroke the gas is under pressure as denoted by the point *C* and then ready for firing. The ignition being effected by the electric spark, the combustion is rapidly propagated throughout the charge, heat energy

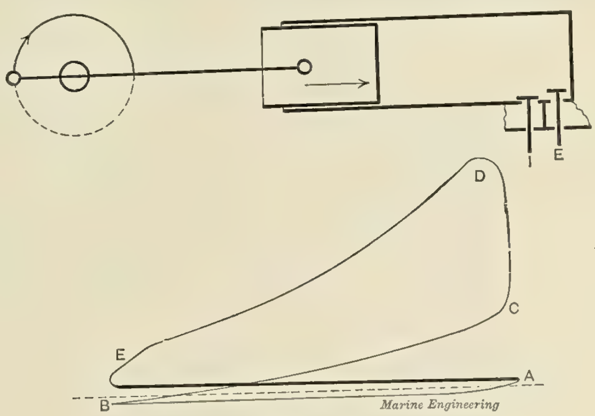


FIG. 4.—FOUR-CYCLE ENGINE, EXHAUST STROKE.

is liberated, and the pressure rises as shown by the line *CD*. At the same time the piston begins its third stroke as shown in Fig. 3, urged by the pressure of the expanding gas, the pressure decreasing as the volume increases as shown by the expansion line *DE*. The entire line *CDE* of the diagram corresponds, therefore, to the operations of combustion and expansion, and gives the history of the relation between volume and pressure for the third stroke of the cycle. During the next stroke the piston returns to its original position as shown by Fig. 4, and the waste gases are rejected through the open exhaust valve. The corresponding line on the indicator diagram is shown by *EA*, thus completing the diagram and the cycle. The following stroke a new cycle begins and the same operations are repeated.

Referring again to these figures indicating the operation of the engine throughout one complete cycle, it will be clear that the gases act on one side of the piston only, the other side being exposed to the constant pressure of the air. Engines operating in this manner are known as "single acting." It is furthermore clear, since the air always acts by pressure inward, that it will oppose the out stroke and aid the in stroke by equal amounts, and that in consequence the pressure of the air exercises no resultant influence on the net work done by the engine. The net work will therefore be correctly given by considering simply the work done by the gas alone. From this point of view it is seen that during stroke No. 1 the gas comes in with pressure as shown

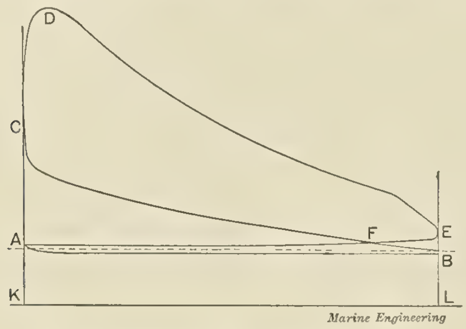


FIG. 5.—INDICATOR CARD, FOUR-CYCLE ENGINE.

by the line *AB*, Fig. 5, slightly below the atmospheric line; but reckoning from the zero of pressure, positive work is done on the piston represented by the area *ABLK*. During the second stroke the gas is compressed and takes work from the engine represented by the area *CBLK*. During the third stroke the gas gives work to the engine represented by the area *KCDEL*, while during the fourth stroke the piston must push the gas out, thereby doing work on it represented by the area *EAKL*. A little thought will show that as the result of these four strokes work is done *by* the gas on Nos. 1 and 3, and *on* the gas on Nos. 2 and 4; and further, that the net work of the cycle will be given by the difference between the two loops of the diagram *CDEF—ABF*.

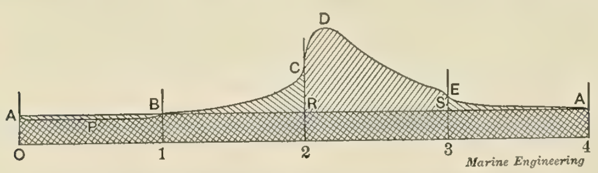


FIG. 6.—DISTRIBUTION OF WORK IN FOUR-CYCLE ENGINE.

While it is evident that the air always pressing in the one direction will not affect the total work of the cycle, it will, nevertheless, affect the net work for each stroke individually, and hence the distribution of net work through the cycle. This is a point of some importance and may be seen more clearly by the aid of Fig. 6.

In this diagram the four lines of Fig. 5 are run out consecutively, the letters being the same in both figures. The four strokes are therefore from *0* to *1*, *1* to *2*, *2* to *3*, and *3* to *4*. The straight line *AA* represents atmospheric pressure and *04* the zero of pressure. Then during the first stroke the work done by the gas and against the air is represented by the area *0APB1*, while the work done on the air is represented by the rectangle *0AB1*. The net work for this stroke is therefore done *on* the air, and is shown by the area *APB*. Similarly during the second stroke the work done on the gas is shown by *1BC2*, and that done by the air is shown by *BR21*. The net work is therefore done *on* the gas, and is shown by the area *BCR*. During the third stroke the work done by the gas is shown by *2CDE3*, and that done on the air by *RS32*. The net work is therefore done *by* the gas and is shown by the area *RCDES*. During the fourth stroke the work done on the gas is shown by *3EA4*, and that done by the air is shown by *3SA4*. The net work is therefore done *on* the gas, and is shown by the area *SEA*. To aid in understanding these various relations, the work done *by* the air or *by* the gas is shown by hatching with lines inclined downward to the left, while work done *on* the air or *on* the gas is shown by hatching with lines inclined downward to the right. The net work for each stroke shows then as a singly hatched area, and the direction of the lines shows whether it is done *by* or *on* the engine. Thus it is clear that for the first, second, and fourth strokes the net work is done *by* the engine either *on* the gas or *on* the air, while for the third stroke the net work is done *on* the engine and *by* the gas. The entire net work for the cycle will therefore be represented by the difference between the area *RCDES* and the sum of the three areas, *APB, BCR, SEA*. A little thought will show that this difference will have the same value as the net result derived from the indicator card of Fig. 5, and as referred to above. It is furthermore evident that the net work of stroke number 3, represented by the area *RCDES*, must be sufficient to provide for the external work (of propulsion, for example) plus the work of internal friction, both for the entire cycle, plus the work represented by the three other smaller areas for the three other strokes of the cycle. It is also clear that the inertia of the moving parts must be depended on to maintain the motion during strokes *1*, *2*, and *4*, for which net work is absorbed rather than given out. This shows in particular the need of a heavy flywheel with a single four-cycle engine giving but one power impulse in four strokes. The application of these principles to multiple cylinder engines will be referred to at a later point. In the meantime it may be noted that the distribution of work through the cycle, as shown by these diagrams, has an important bearing on the operation and adaptation of the engine for various purposes, and the interested reader is urged to obtain a thorough grasp of these various diagrams and of the facts which they represent.

(To be continued.)

THE COURSES IN MARINE ENGINEERING AND NAVAL ARCHITECTURE AT COLUMBIA UNIVERSITY.

BY PROF. AMASA TROWBRIDGE.

In looking over the field of naval architecture and marine engineering to-day, we see that we are in the midst of a period of development that promises many new things before its completion. The steam turbine and the gas engine have been tried and found available, and will both be brought to practical perfection in the next few years. This is just what is to be expected, if we judge from the development that has taken place in this field in the last century. In the course of this development, many of the steps have been first taken in the United States, though for many years we have done a very small percentage of the shipbuilding of the world. It is probably due to the fact that we have done so little of the recent shipbuilding, that we were so long without any schools of naval architecture and marine engineering. This is a lack that can hardly be laid at the door of those who were conducting our scientific and technical schools, as they have shown themselves extremely ready to adopt suggestions in the line of new courses. Rather, it must have been due to the lack of demand for highly trained scientific men in the shipbuilding industry. As our shipbuilders have begun to compete with the shipyards of other countries, notably those of Great Britain and Germany, it has been found necessary to have a corps of highly trained men, familiar with the reasons for doing things, as well as with the methods of doing them. To get these men, many of the shipyards have employed foreigners, or those who were educated in foreign schools. The results have not always been what were expected and have seldom been what was desired. Very few of these men have been able or willing to put themselves into a proper place in the system of an American shipyard, and the consequence has been an utter lack of co-operation.

Without an adequate system and a fair degree of co-operation, no industry of the magnitude of a shipbuilding plant, and especially one dealing with such a variety of work and processes, can be carried on successfully. Then, too, few industries present the difficulties to be found in shipbuilding. The work is large, but it must be done with great care. The various parts must be assembled in a certain order, and must fit each in its respective place; but they must frequently be made in different parts of the works, and often in different works. In designing the ship, each part has a direct influence on many others, yet the whole design problem is so large for a big ship that many men must work on it at once. This tends, of course, to lead to many delays and much confusion, from changes made by one man necessitating changes in parts designed by another man. To meet these difficulties, it requires men who are in sympathy with the ideas of those who are directing the work, and who are also interested in the development of new methods for doing the work. To us new methods are a necessity. Labor is higher priced here than in Europe, but materials need be no higher. The fact that steel, the material from which most of the ship is built, costs more here at present, is no proof that it *must* cost more. In fact, when our steel manufacturers find no room for their product in the home markets, they can easily undersell foreign steel makers, delivering the material across the water for actually less than it can be manufactured there. Hence we see that if the American shipbuilder can introduce enough labor-saving devices, he should be able to compete with the foreign builders.

It has been the experience of many reformers of manufacturing processes that, to make their reforms successful, they must educate young men to do the work rather than get experienced men, who were accustomed to the old methods, to change their ways. Shipbuilding is no exception to this rule.

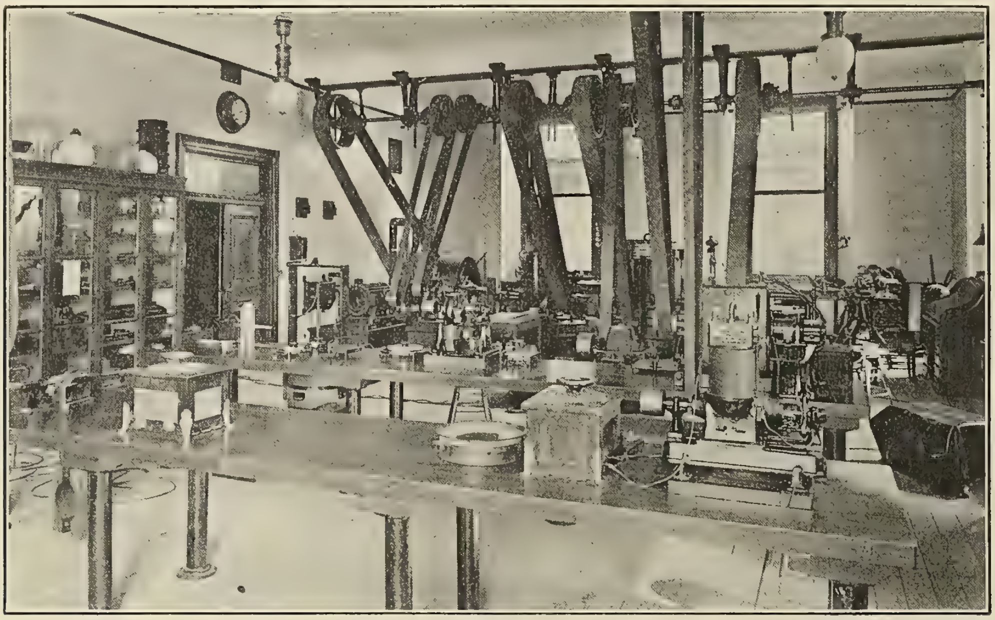
To meet the demand for highly trained men in shipbuilding, some of our American universities have offered marine courses. This was done at Columbia University about five years ago, and the courses have been undergoing development ever since. Located at the very center of American shipping industries, Columbia has unequaled facilities for instruction in naval architecture and marine engineering. The ships of all nations come to her very doors, and she is literally surrounded by yards where the building and repairing of vessels is constantly being carried on. The greatest navy yard in America, that in Brooklyn, is within easy reach, and here many examples of warship construction can be seen, as the vessels of our navy, from the smallest launches to the largest battleships, are built or repaired. Also, in Brooklyn, Staten Island, and on the New Jersey shore are shipyards where naval and merchant vessels are built and repaired. Then, too, only a few minutes' trip northward brings us to the Harlem River, where some of the most advanced types of high-speed vessels, yachts, and torpedo boats are constructed.

GENERAL VIEW OF COLUMBIA UNIVERSITY.

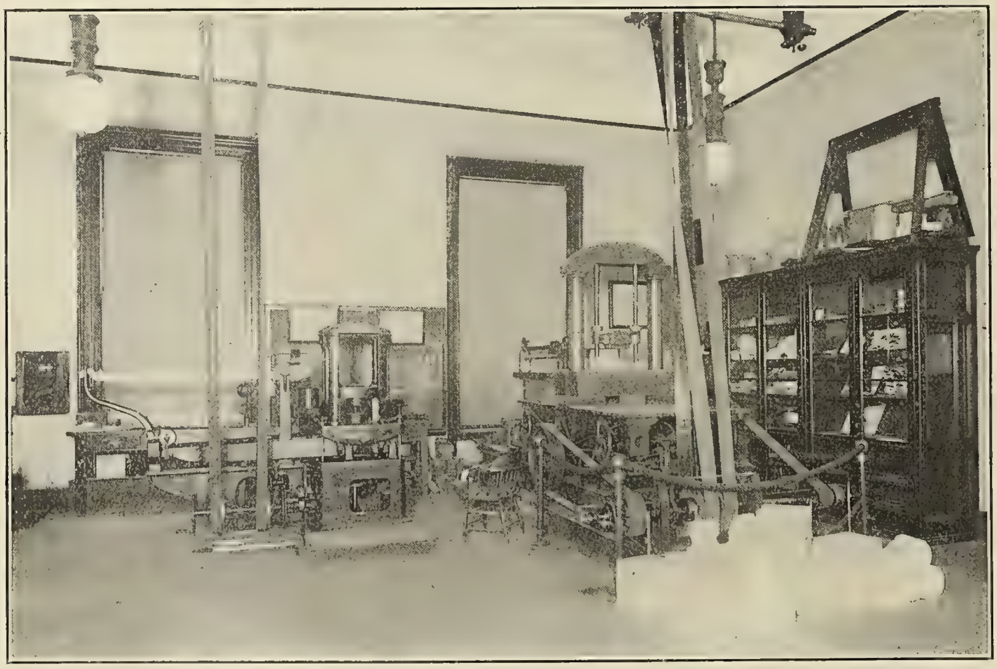
The course in Columbia is a four years' course, covering as broadly as possible the necessary subjects which it is desirable a man should understand to fit him for the profession of naval architect or marine engineer. The first and second years are largely devoted to the fundamental studies, such as mathematics, physics, and chemistry, and the third and fourth years to the more purely technical studies. One of the strong features of the course is the engineering laboratory work, in which the student is required not only to perform experiments, but also to analyze his results, thus enabling him to gain a proper perspective from which to judge probable results from similar conditions in any other case. The laboratory is very completely equipped with the various types of engines, including a reversing engine fitted with Stephenson link motion. A 30-horsepower steam turbine is also installed, and can be readily used for almost any kind of experiment, as it can be placed in any convenient spot, no foundation being required on account of its perfect balance. The effect of multiple expansion of steam can be studied, as there are single, compound, and triple-expansion engines of various types. There is also a variety of air compressors, so that one-, two-, or three-stage compression can be studied.

In connection with the steam engineering laboratory is a large hydraulic laboratory, containing a great variety of pumps and pumping engines. These pumps are of different designs, and are for pressures ranging from a few pounds to five thousand pounds per square inch. Large tanks are provided so that the feed and discharge can be accurately measured, and these tanks can also be fitted up for special experiments. There is also a section of the laboratory devoted to internal combustion engines. Here various types of engine are installed, and among others there is a two-cylinder, gasoline-boat engine with all details of gasoline tank, carburetor, muffler, and ignition battery.

The drawing and design courses are carried on in the large drawing rooms, which are located on the upper floors of the engineering building. These rooms are splendidly lighted, having very large windows and a good supply of arc electric lights for use on dark days. In connection with the drawing rooms, there is a carefully selected reference library, containing certain trade publications and technical papers which are not found in the main library of the university. In this library are also kept blue-prints, photographs, and drawings for illustrating points in ship and engine construction. This collection is already quite extensive and is being constantly enlarged.



THE ELECTRIC TESTING LABORATORY.



LABORATORY FOR TESTING MATERIALS OF CONSTRUCTION.

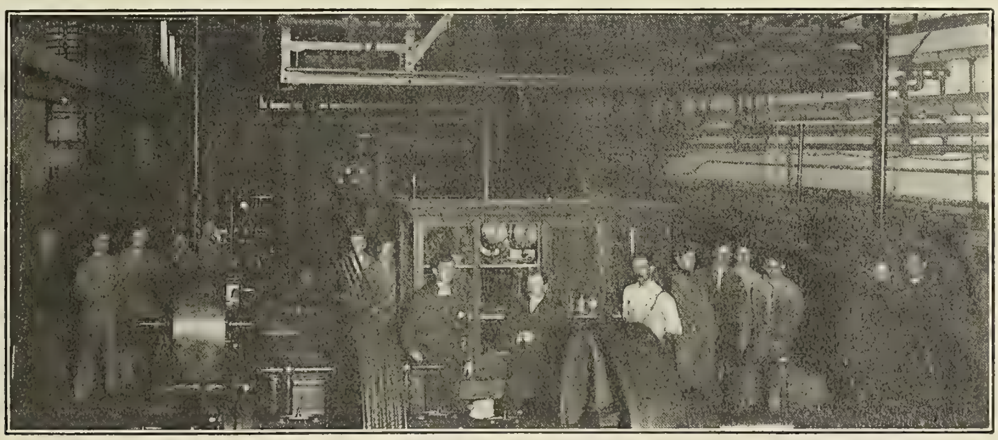
During his first two years, the student is required to take courses in shop work, which are further extended by two summer classes, so that he will derive the advantages possible from continuous work in the shop. Then, in connection with his marine work, visits are paid by the student to the various yards where vessels are under construction, and he sees the processes which are peculiar to shipbuilding. As the students are accompanied on these visits by the professor in charge of the course, the time is spent in seeing and learning the useful points, rather than in sight-seeing. The different kinds of riveted work are particularly studied on these visits. Considerable attention is also paid to the order in which the material is put into the ship, and the methods of handling the material. As almost all the methods of handling material now in use can be found at one yard or another in the vicinity, this problem can be studied very thoroughly. In some of the smaller yards much of the material is still handled by derricks and gin-poles, while the most modern methods of handling with cranes are found in others, such for instance, as the Brown cantilever crane on an elevated runway, which is in use at the Brooklyn navy yard.

Wherever it is possible, attention is called to the different ways of doing various things, such as making plating joints. Such comparisons as are possible are made, and the students are required to make rough calculations of the various items so as to impress them on their minds. An illustration of this is: after explaining how a deck is laid with joggled plates and an example of this method has been studied, count the number of tapered liners that have been omitted and estimate the weight saved by the use of the joggled plates. Attention is also called to the fact that the liners must be put in place, marked, returned to the shop and punched, before they are ready to be finally placed. This indicates to the student the items to be considered in estimating the cost of the two systems. These inspection visits are of great value in assisting him to apply the principles he has studied to actual conditions, and are made as frequently as possible. Some of the trips are to vessels in the harbor, instead of to the building yards, in order to study different kinds of ships and see what are the best types of each particular service. It is also possible on these trips to compare the products of the various shipbuilders, American and foreign.

The marine course at Columbia is especially broad, and yet each subject is taken up so thoroughly as to avoid inculcating habits of superficiality. As this latter point is particularly to be avoided, frequent quizzes are given in all the studies, and the students are required to pass a final examination in each subject, to insure their understanding it thoroughly. By this method the instructor knows, at any time, what each student is doing, and the students are able to know what progress they are making.

In the more purely marine subjects, the course in theoretical naval architecture runs through the entire fourth year, and treats of the following: Methods of calculating areas and volumes as applied to ship forms; displacement; moments of areas and volumes; center of buoyancy; metacenters; statical stability; center of gravity; dynamical stability; trim and moment to alter trim; stability in damaged condition; stability in launching condition; theory of waves; rolling of ships; strains experienced by ships; strength of ships; steering.

ONE CORNER OF THE MARINE DRAWING ROOM.



THE MECHANICAL LABORATORY.

The course in ship calculations is carried parallel with the naval architecture, and includes the working out of a displacement sheet and the usual curves of tons per inch of immersion, stability, buoyancy, and the equivalent girder. In making these calculations, the student becomes familiar with the use of the mechanical integrator and planimeter. The course in marine engine and boiler design covers the principles of such design work, and these are emphasized by the working out of the engines, boilers, condensers, etc., for the ship treated in the other courses.

The course in shipbuilding is principally a course in ship drafting. In this a set of lines is first drawn and faired. The midship section is then drawn according to Lloyd's rules, or the rules of a similar classification society. This section is then studied with a view to improvement, and, if possible, is strengthened by simply rearranging the material. Its strength is then considered in comparison with the maximum bending moment that the ship might encounter. After the midship section is complete, the inboard profile and deck plans are drawn, the boilers and engines being put in which have been calculated in the engine design course. In making these drawings, the students become familiar with the rolled steel sections used in ship work, as well as with the methods of designing ships. Special attention is also given to the use of standard fittings in this design work, and the students are encouraged in criticizing the design of fittings that they find on drawings of other ships. Merchant work is taught almost exclusively in this course, because it is not considered advisable to teach the students the costly type of construction used on naval vessels at the beginning of their professional careers.

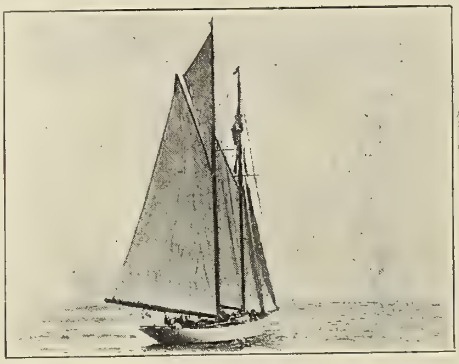
The course in propulsion treats of the kinds of resistance; the relative value of the different resistances; the law of mechanical similitude; the powering of ships; propeller design. The last subject is very thoroughly covered by problems.

The marine seminar consists chiefly in the reading and discussion of reviews, written by the students, of articles in the technical papers. This exercise has a manifold value. It not only makes it necessary for the student to read the article assigned, but he must also look up the whole subject, as far as his time permits. He also hears the reviews of the articles assigned to other students, and the discussion of them. More important than either of these, it gives him training in expressing himself, and practice in analyzing technical subjects.

Before receiving his degree, the student is required to submit an acceptable thesis. This can be on any subject which has a close relation to the work of his course, and may consist of an analytical discussion of some problem, an experimental determination of some fact, or a design of some vessel or part of a vessel. The work on this thesis must, however, be original, and nothing that is simply copied from the writings of others will be accepted.

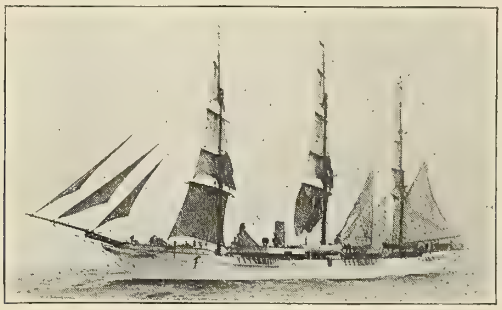
As the training for a naval architect or a marine engineer is so closely allied to that for a mechanical engineer, the courses outlined above are based on the mechanical engineering course that was in existence when the marine courses were organized, and the degree given for the latter is that of mechanical engineer. The university also offers a number of courses which lead to higher degrees, and which are particularly valuable to either a naval architect or a marine engineer.

APACHE.



HILDEGARDE.

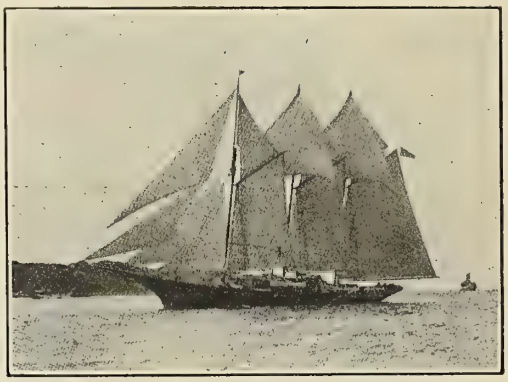
SUNBEAM.



VALHALLA.

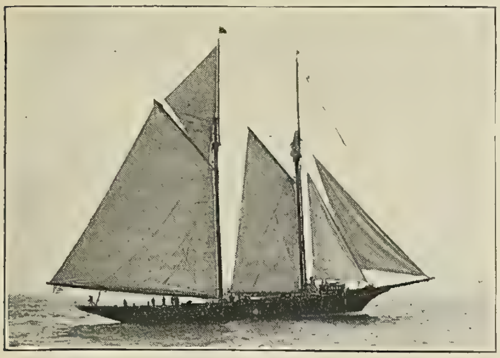
The International Ocean Yacht Race.

Early in the evening of the 29th of May, the three-masted schooner-yacht *Atlantic*, belonging to Mr. Wilson Marshall, designed by Mr. William Gardner, and built by the Townsend-Downey Shipbuilding Company, crossed the line south of the Lizard lighthouse in England, and thereby won the race for the cup offered by the Emperor of Germany. The time of the *Atlantic* was very fast, she having occupied on the passage but 12 days 4 hours and 1 minute for a total of 3,028 miles. This gives a speed from start to finish of about 10.5 miles per hour, which figure would have been considerably increased had it not been that a calm resulted in her occupying about 12 hours in covering the distance from the Scilly Islands to the Lizard.



UTOWANA.

The German schooner-yacht *Hamburg*, which was the second to finish, covered a distance of 3,093 miles in 13 days 2 hours and 6 minutes, being thus 22 hours and 5 minutes longer on the trip than was the *Atlantic*. Her speed was 9.85 miles per hour. The English ship-rigged *Valhalla*, and the American schooner *Endymion* finished third and fourth respectively, and thus took the



HAMBURG.

THE CUP.

ATLANTIC.

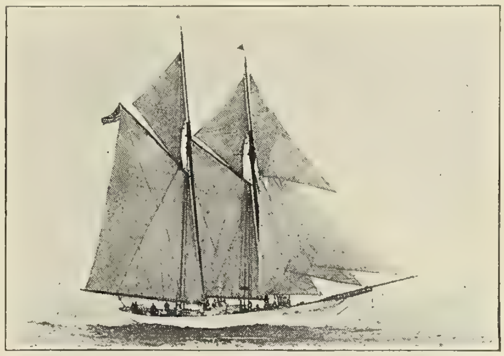
prizes corresponding with those positions. The other yachts entered in the race finished in the order given in the appended table, which gives their time at the finish, the elapsed time from the start, and the margin which the *Atlantic* had over each of them.

ENDYMION.

One very noteworthy feature in connection with the finish of this race was that the first nine of the eleven yachts crossed the line between 7:15 P.M. and 5:15 A.M. In other words, only the last two finished the race in full daylight. Another noteworthy feature is the fact that although the *Ailsa* finished more than half an hour ahead of the *Utowana,* yet the difference in starting time was such that the elapsed time of passage on this 3,000-mile trip was just one minute greater for the *Utowana* than for the *Ailsa.*

No.	Yacht.	Start, May 17.	Finish.	Elapsed Time. d.	h.	m.	Lead of Atlantic. d.	h.	m.
1	Atlantic........	12.16 P.M.	May 29, 9.17 P.M.	12	4	1	..	..	..
2	Hamburg......	12 17 "	" 30, 7.23 "	13	2	6	0	22	5
3	Valhalla.......	1.05 "	" 31, 8 08 "	14	2	3	1	22	2
4	Endymion	12 17 "	" 31, 9.34 "	14	4	17	2	0	16
5	Hildegarde....	12.15 "	" 31, 10.08 "	14	4	53	2	0	52
6	Sunbeam......	12.32 "	" 31, 11.40 "	14	6	8	2	2	7
7	Fleur de Lys ..	12.27 "	June 1, 2.48 A.M.	14	9	21	2	5	20
8	Ailsa...........	12.15 "	" 1, 4.25 "	14	11	10	2	7	9
9	Utowana	12.55 "	" 1, 5.06 "	14	11	11	2	7	10
10	Thistle	12.18 "	" 1, 12.45 P.M.	14	19	27	2	15	26
11	Apache........	12.35 "	" 5, 10.20 A.M.	18	17	5	6	13	4

Our illustrations are from *Literary Digest.*

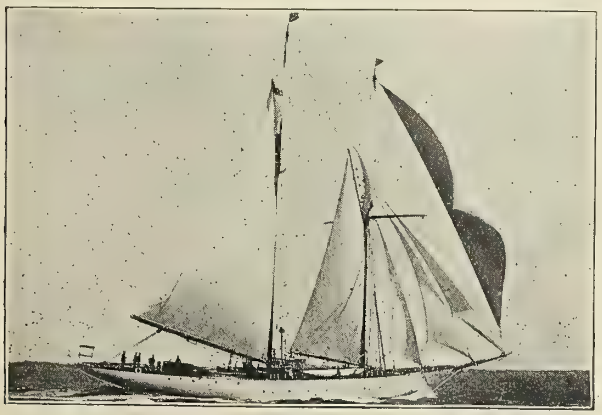


FLEUR DE LYS.

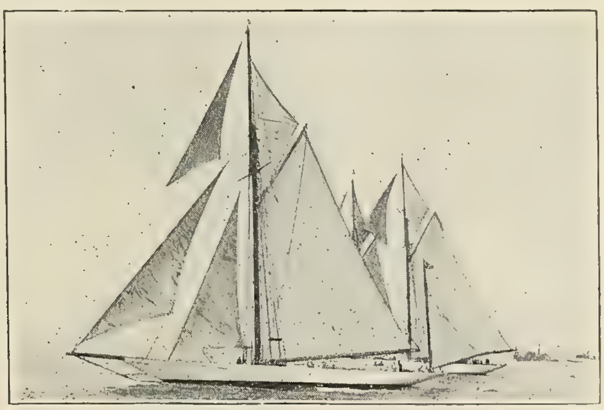
Early Ferryboat Expenses.

In the Engineers' Club of New York is the original of a letter written by Robert Fulton, and dated January 22, 1810, which gives an interesting estimate of the cost at that time of operating a ferryboat, the estimate being made for one year as follows:

"Two firemen at 30 dollars a month each, they finding themselves, they will also act as engineers to keep the engine in order, they must be engaged for the year, as such men cannot be turned away in the winter and got in the spring = 60 dollars a month—	$720.00
"Two Boatmen to take turns in steering at 25 dollars a month each, 50 dollars a month,	600.00
"1½ Cords of wood for 12 or 13 hours at 4½ dollars a cord, or say 7 dollars a day to work 320 days	2240.00
"Ware tare and Repairs	600.00
"Total	$4160.00"



THISTLE.



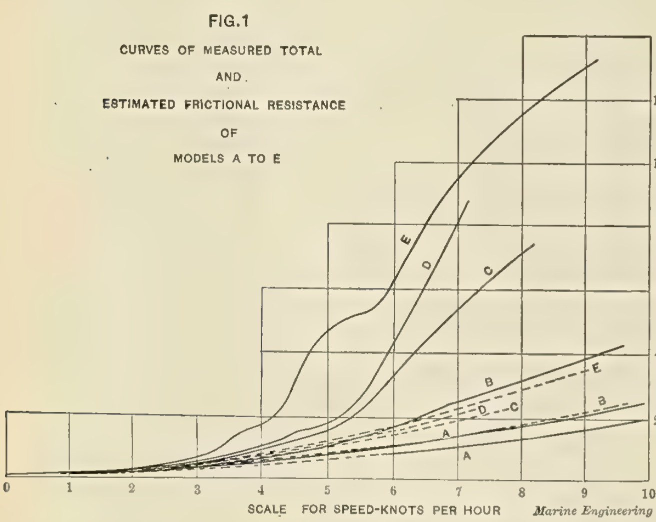
AILSA.

LAWS OF VARIATION OF RESISTANCE OF SHIPS.

BY D. W. TAYLOR, U.S.N.

For many years, until knowledge of experimental results obtained at model basins became disseminated, naval architects sought some simple formula expressing the resistance of a given ship as a function of its speed. The so-called "Admiralty coefficients" were based upon the assumption that the resistance of a ship varies as the square of its speed. Many other formulæ, some of them very complicated, have been proposed. Analysis of model basin experiments soon shows that the assumption upon which the "Admiralty coefficients" are based is radically in error, except for very low speeds, and that there is no possible simple formula covering the ground; that is to say, it is impossible to adequately express the resistance of a ship by a simple formula such as $r = cV^n$, where r is resistance, V is speed in knots, and c and n are constants. It is possible at any point on the curve of resistance to determine values of c and n, such that a curve drawn with these values touches the curve of resistance at the chosen point, but these values of c and n change rapidly and radically with speed.

Fig. 1 shows curves of total resistance as determined by experiment and of estimated frictional resistance, for five models, A, B, C, D, and E, whose characteristics are given in Table 1. The curves in full lines are the actual curves of resistance of the models. The curves in broken lines are the curves of estimated frictional resistance of the models. It is evidently absurd to suppose that lumpy, irregular curves, such as some shown in Fig. 1, can be adequately represented throughout any large portion of their length by the formula $r = cV^n$. Three of the models referred to in Table 1 are of actual vessels, A being a torpedo boat, B a destroyer, and D a cruiser. Model C was on the lines of an actual cruiser with modified dimensions, and model E was from a design of a 600-foot collier of 21,000 tons displacement, with a parallel middle body extending for 260 feet. This model, of course, was not adapted to high speeds, the actual intended speed being 14 knots, and the corresponding speed of the model as indicated in Table 1 being but 2.55 knots. It will be noted from Fig. 1 that all of the curves extend to higher speeds than the corresponding speeds of the actual ships. From the curves of Fig. 1 there have been calculated the values of the index n in the formula $r = cV^n$ above, and the results are plotted as curves in Fig. 2. These results show the impossibility of using any simple formula such as $r = cV$. Curves of c corresponding to the curves of n of Fig. 2 would be still more erratic than the curves of n. It must not be supposed that the anomalies of Fig. 2 are accidental. They are characteristic. Such curves for any models taken at random would show similar anomalies.



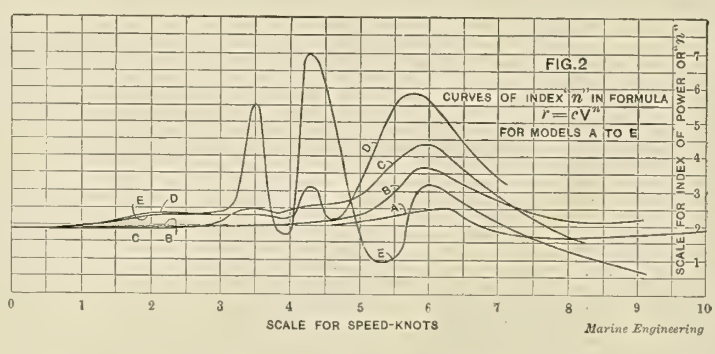
Returning to Fig. 1, we observe that the curves show a number of humps and hollows, the maxima of Fig. 2 corresponding to the humps and the minima to the hollows. These humps and hollows are due simply to the favorable or unfavorable conjunction of the two systems of waves naturally set up, one at the bow and the other at the stern of the model. In the case of a full model these waves are appreciable at low speeds, and hence we find a hump at the speed of 3 3-4 knots for a 20-foot model. There is then a hollow, followed by a marked hump at about the speed of 4 1-2 knots, succeeded by a hollow, and a final hump at a speed a little over 6 1-2 knots. The latter hump corresponds to the condition of affairs when there is a wave crest at the bow, the bulk of the vessel is in the succeeding hollow, and the second crest of the bow wave system appears abaft the stern, where it reinforces the stern wave. Evidently, beyond this speed there can be no further hump, since there is no other wave crest to move aft with increasing speed and reinforce the stern wave. For all speeds beyond this hump the ship is traveling on the back of the bow wave, so to speak.

TABLE I.—DIMENSIONS, ETC., OF MODELS A TO E.

Model	A	B	C	D	E
Displacement of model in pounds	316	533	1140	1558	1694
Length of model in feet	20	20	20.6	20.32	20
Beam of model in feet	1.504	1.876	2.676	2 328	2.076
Mean draught of model in feet	.455	.562	.670	.950	.863
Area of midship section, square feet	.4455	.7354	1.545	2.113	1.734
Midship section coefficient	.651	.697	.8616	.9554	9678
Block coefficient	.3694	.404	.493	.5548	.756
Cylindrical coefficient	.5674	.579	.573	.581	.781
Corresponding speed knots*	9.37	8.15	4.94	4.42	2.55
Value of $\frac{V}{\sqrt{L}}$ for designed full speed	2.095	1.822	1.104	.988	.570
Value of $\frac{D}{\left(\frac{L}{100}\right)^3}$	17.63	29.74	58.22	82.89	94.53

* This is speed of model corresponding to designed speed of full size vessel.

For very fine models, such as A and B, the low-speed humps and hollows are not appreciable for the reason that at the speeds at which they are due to appear the wave disturbances made by fine models are very slight. For such models, 20 feet long, the 6 1-2-knot hump is the only one which appears in practice, and even that is not usually very strong. For 20-foot models pushed to a speed of about 14 knots there is a curious kind of small secondary hollow, the cause of which is not clear. As we make a model more and more bluff, the 4 1-2-knot hump assumes more and more prominence, until for models with cylindrical coefficients above 0.625, it is usually very strong. There is one curious fact which is exemplified in Fig. 1, which is, that for each model, as a rule, there is but one very pronounced hump. For a full model the 4 1-2-knot hump is very pronounced, whereas the 6-knot hump is relatively much less prominent. For fine-ended models, however, the 4 1-2-knot hump may be hardly perceptible, but the 6-knot hump much stronger than for the full-ended models. Hence, for vessels intended to be driven at speeds in the neighborhood of the 4 1-2-knot hump it is very favorable to speed to make the ends fine. This reduces the 4 1-2-knot hump and amplifies the



6-knot hump. The above fact is one having great influence upon the preferable shape for high-speed torpedo boats and destroyers, for which the corresponding speed of a 20-foot model is greater than 6 knots.

Accepting the fact that the formula $r = cV$ cannot adequately represent the resistance of a vessel, the question arises whether we can find some approximate method or formula of value in practice, or must rely only on model-basin experiments. The method pursued in the model basin may be summarized as follows: From the total resistance of a model at a certain speed we deduct the skin or frictional resistance of a surface of area the same as that of the immersed surface of the model driven through still water at the speed in question. To the remaining resistance of the model, which we call the residuary resistance or wave resistance, since it is practically all wave resistance, we apply the law of comparison and deduce the residuary resistance of the full-sized ship at the speed corresponding to that of the model. We then calculate the frictional resistance of the full-sized ship. It is seen then that even when using model-basin experiments we calculate from tabular data the skin friction of the full-sized ship, using Froude's or Tideman's coefficients. Fig. 3 shows Tideman's coefficients for smooth steel surfaces of ships, plotted upon logarithmic intervals of speed as straight lines, showing the frictional resistance in pounds per square foot of wetted surface for vessels of any length and speed. Froude's coefficients give slightly less friction than Tideman's, but it is thought that for ordinary ships, and especially for estimating purposes, Tideman's results are preferable. In order to use Fig. 3 we need to know the wetted surface of the ship in square feet. A close approximation to the wetted surface of the hull proper of a given vessel of length on water-line in feet $= L$ and displacement in tons $= D$ may be obtained from the formula $S = 15.5 \sqrt{DL}$, where S is wetted surface in square feet. This formula does not apply to very broad, shallow vessels whose beam is over 3 1-2 times the mean draft. If it is desired to allow a small margin for appendages to hull proper, etc., we should use $S = 16 \sqrt{DL}$. Since, then, we can calculate closely the skin friction of a ship, we need an approximate method for the determination of residuary or wave-making resistance only. A full discussion of residuary resistance will be found in works on naval architecture. Rational formulæ for this resistance would be of the form $W = bV^4$, where W is the residuary resistance, V the speed in knots, and b a coefficient which for moderate speeds may be expected to oscillate about an average value, and for high speeds to steadily fall off. Fig. 4 shows for the residuary resistances of Fig. 1 curves of values of b. The maximum values of b of course correspond to the humps of the curves, and the minimum values to the hollows. It is seen that for model E there is a notable hump in the curve of b at a speed somewhat under 5 knots. For models C and B the notable maximum corresponds to the 6 1-2-knot hump, while for the fine models the coefficient falls off all the way. It should be pointed out, however, that for speeds below 3 knots the actual residuary resistance is very small, and it makes very little difference what the value of b may be.

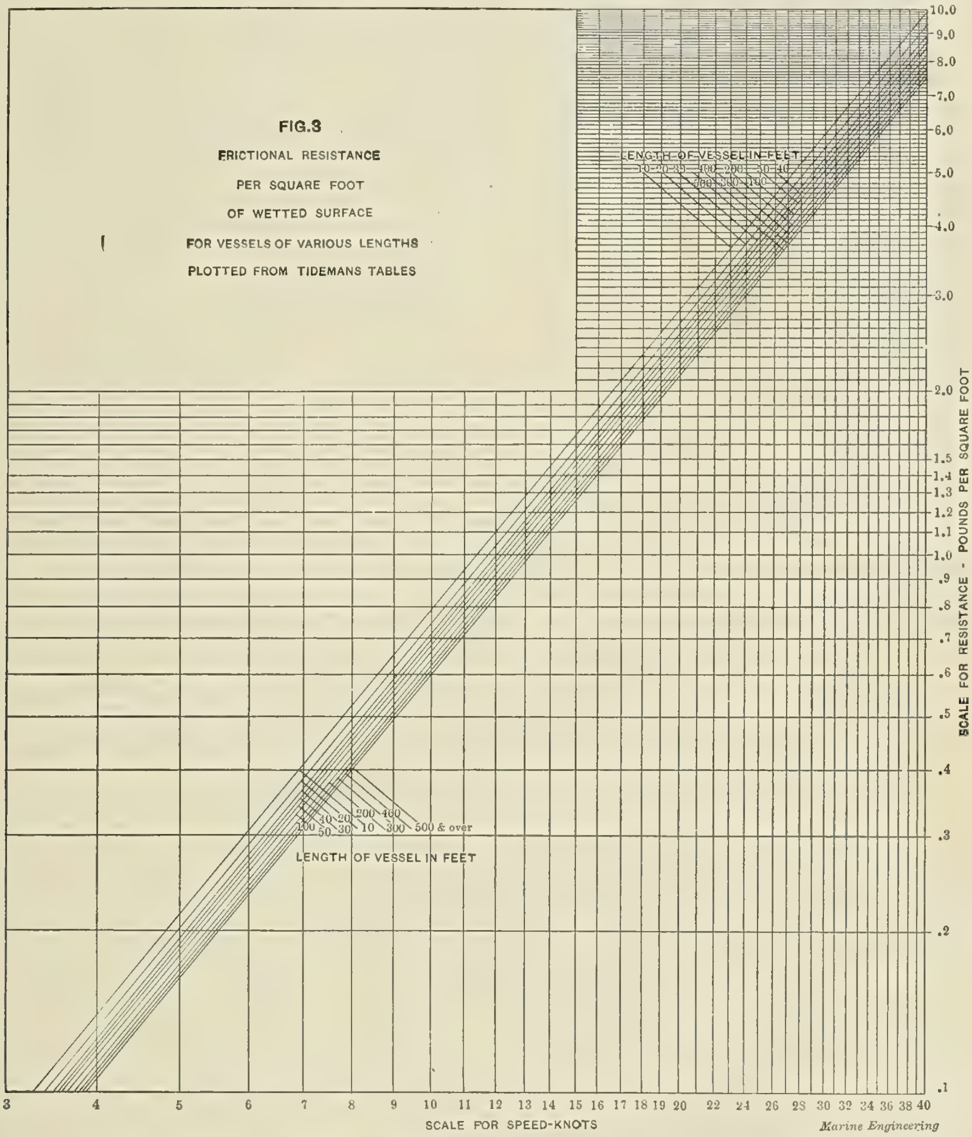
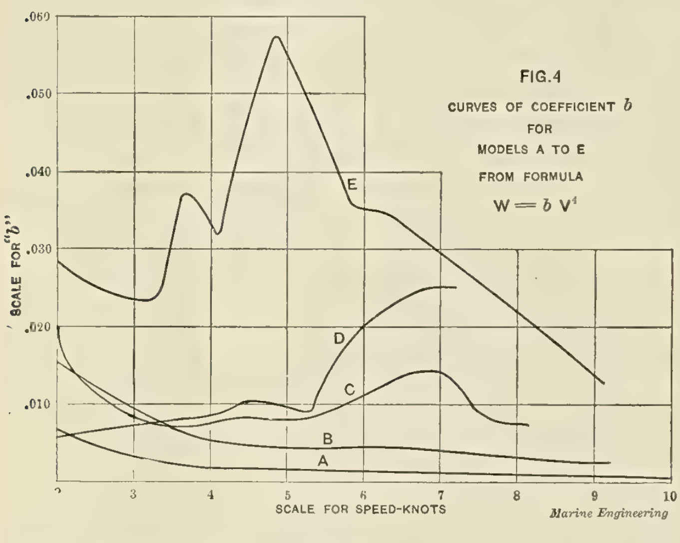


FIG. 3
FRICTIONAL RESISTANCE PER SQUARE FOOT OF WETTED SURFACE FOR VESSELS OF VARIOUS LENGTHS PLOTTED FROM TIDEMANS TABLES

Of course, the coefficient b above depends upon the dimensions, proportions, and shape of the vessel. In "Resistance and Propulsion" a number of years ago the writer suggested using for b $b_0 \times \frac{D^{\frac{2}{3}}}{L}$. Then b_0 does not change with change of dimensions of similar vessels, although it would change with change of proportion and shape.

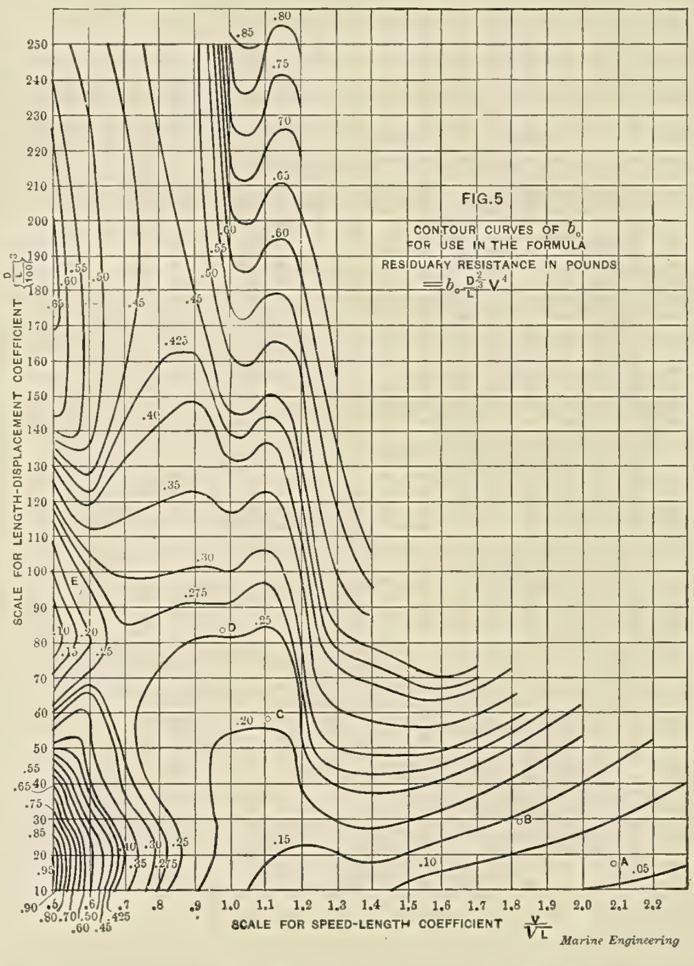
Investigation of values of b_0 from results of model experiments indicates that, broadly speaking, the length and displacement are the primary factors affecting the residuary resistance. This, of course, applies to well and fairly shaped models. The resistance of a square-ended scow of a given length and displacement would be enormously greater than that of a fair ship of the same length and displacement. Considering fair models, however, of ordinary types, it is quite evident from model-basin results that the length adopted for a given displacement has, broadly speaking, a much more powerful influence upon the wave resistance at a given speed than ordinary variations of fineness, of proportions of beam to draft, etc. This does not mean that fineness of a vessel of given length and displacement does not affect the residuary resistance, but that the effects of such variations of fineness as would ordinarily be found in designs by different naval architects are rather secondary as compared with the effect of length for displacement. Without discussing the question fully, it may be remarked that when $\frac{V}{\sqrt{L}}$ is not greater than 0.8 very large variation of block coefficient appears to produce little effect upon the resistance of a vessel. The block coefficient may vary from 0.55 to 0.66 or more



without serious change of resistance. Above $\frac{V}{\sqrt{L}} = 0.8$, however, the effect of the fineness rapidly increases. A model of block coefficient above 0.55 can be driven to a speed $\frac{V}{\sqrt{L}} = 1$ only by a disproportionate expenditure of power, and for higher speeds still the block coefficient should not exceed 0.5.

When plotting results for general application it is advisable, instead of using the actual speed of a vessel, to use the actual speed divided by the square root of the length. This makes comparable results from ships of various lengths. The phenomena of the humps and hollows occur at almost constant values of $\frac{V}{\sqrt{L}}$, whereas, if the curves of vessels of varying lengths were plotted upon their speeds only, these phenomena would of course occur at different speeds.

Fig. 5 shows contour curves of values of the coefficient b_0 above, plotted upon values of $\frac{V}{\sqrt{L}}$ as abscissæ and values of $\frac{D}{\left(\frac{L}{100}\right)^3}$ as ordinates. These contour curves express average results obtained from a large number of models, and, while by the use of Fig. 5 we cannot expect to obtain more than a rough approximation to the residuary resistance in the case of any given vessel, this figure represents with fair accuracy the nature of the broad features of variation of residuary resistance for ordinary vessels without parallel middle body. No models of speed launches were used in obtaining Fig. 5, and for such an extreme type of vessel, or any other extreme type of vessel, Fig. 5 cannot be depended upon to give a close approximation. For actual application Fig. 6 is more convenient than Fig. 5. Instead of curves of the coefficient b_0 this gives curves of resistance in pounds per ton of displacement throughout the range of speed and displacement likely to be needed for vessels of ordinary types. The application of this figure in practice is comparatively simple. Taking a vessel of given dimensions and displacement, the value of $\frac{D}{\left(\frac{L}{100}\right)^3}$ is a constant, and values of $\frac{V}{\sqrt{L}}$ for any desired speeds



are readily calculated. Entering Fig. 6 with a constant value of $\frac{D}{\left(\frac{L}{100}\right)^3}$ we take off for as many values of speed, or $\frac{V}{\sqrt{L}}$ as desired the residuary resistance in pounds per ton, interpolating as necessary; and knowing the displacement in tons, calculate the total residuary resistance. Then calculate the frictional resistance from Fig. 3. Adding together the frictional and residuary resistances the total resistance for a given speed is obtained. I should again repeat that Fig. 6, deduced as a kind of average from results of a large number of models, must be regarded simply as a rough approximation.

Figs. 5 and 6 are really the same. In fact, Fig. 5 was obtained from the curves of Fig. 6. The eccentricities of the coefficient b_0 shown in Fig. 5, are more apparent than real. The large values occurring in the lower left-hand corner of the diagram are of no

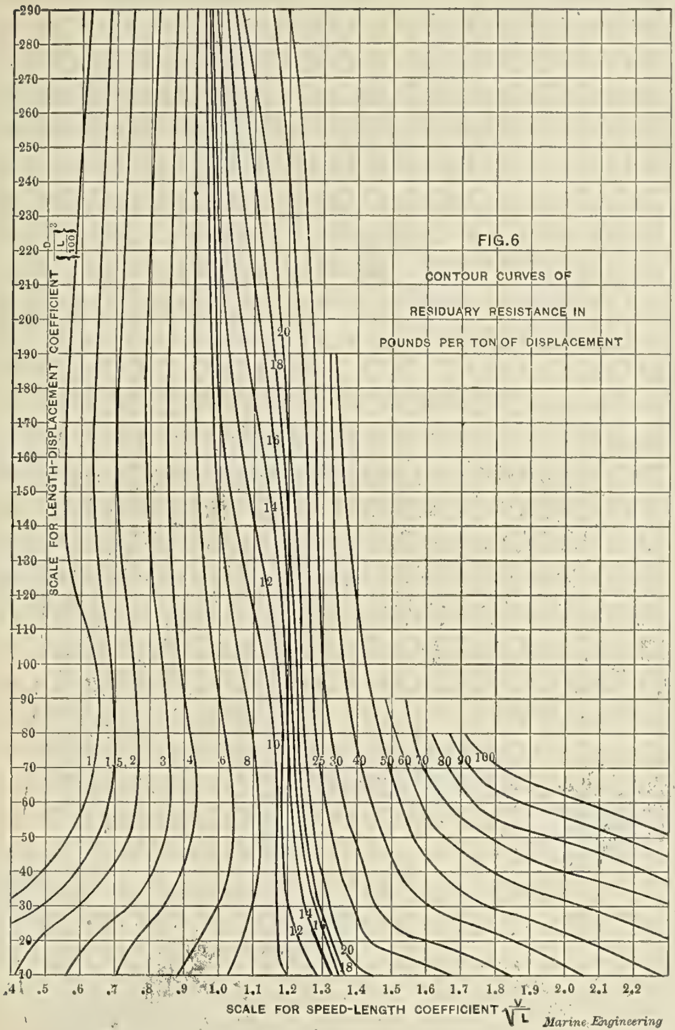


FIG. 6
CONTOUR CURVES OF RESIDUARY RESISTANCE IN POUNDS PER TON OF DISPLACEMENT

importance in practice, that part of the diagram referring to low speeds of vessels which are exceedingly long and fine.

In "Resistance of Ships and Screw Propulsion" the writer attempted to fix approximate values of b_0 from such published results of model-basin experiments as were available fifteen years ago. At that time the fair average value of b_0 which was adopted for moderately fine, high-speed vessels, was 0.4, rising to 0.45 or more for vessels which were broad in proportion to their length, and falling to 0.35 or less for vessels which were long and moderately fine. Bearing in mind that for the vast majority of fast vessels at full speed the speed length coefficient will be found between 0.8 and 1, it is seen that the above values of b_0 are not seriously in error for practical purposes, except for vessels which are exceedingly fine and exceptionally long. For such vessels the coefficient b_0 is small, and, if they are pushed beyond a speed length coefficient of 1.4, the coefficient appears to steadily fall off. On Fig. 5 the lettered spots indicate the values of $\frac{D}{\left(\frac{L}{100}\right)^3}$ and of $\frac{V}{\sqrt{L}}$ at maximum designed speed for the five models A to E.

Fig. 7 repeats in full lines the original resistance curves of total resistance of models A to E of Fig. 1, and shows also by broken lines the corresponding curves as calculated from Figs. 5 or 6, the frictional resistance being taken as the same in each case. It is seen that the calculated curves follow the actual curves reasonably closely throughout, except in the case of model E. This illustrates the fact that Figs. 5 or 6 are to be regarded as rough approximations to facts for actual vessels of usual type, but are of little or no use when applied to extreme or impossible types of vessels. The speed of model E, corresponding to the actual designed speed of the vessel, was but 2.55 knots, while in Fig. 7 the resistance is shown for a speed as high as 9 knots, corresponding to about 49 knots for the full-sized vessel. Of course, no one would design such a vessel with a cylindrical coefficient of 0.781 to be driven at high speed. It will be noted that the displacement of model E is not much greater than that of model D, the latter being properly shaped for a high speed. Figs. 5 or 6 may readily be used to determine the length necessary to obtain the absolute minimum resistance for a vessel of given displacement. Upon doing this it will be found that for a high-speed vessel the length for minimum resistance is in every practical case beyond the length that is desirable, and in most cases beyond the length that is at all practicable. This result, however, is in exact accordance with the facts as determined by model experiments. It is seldom possible in practice in the case of an actual vessel intended to be driven at a speed for which $\frac{V}{\sqrt{L}}$

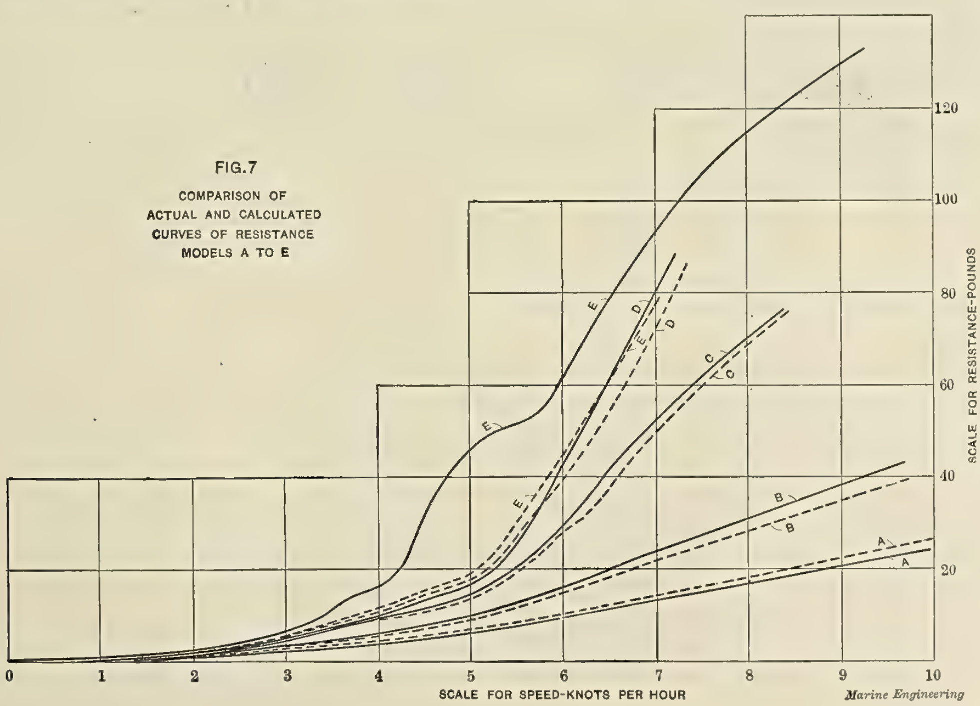


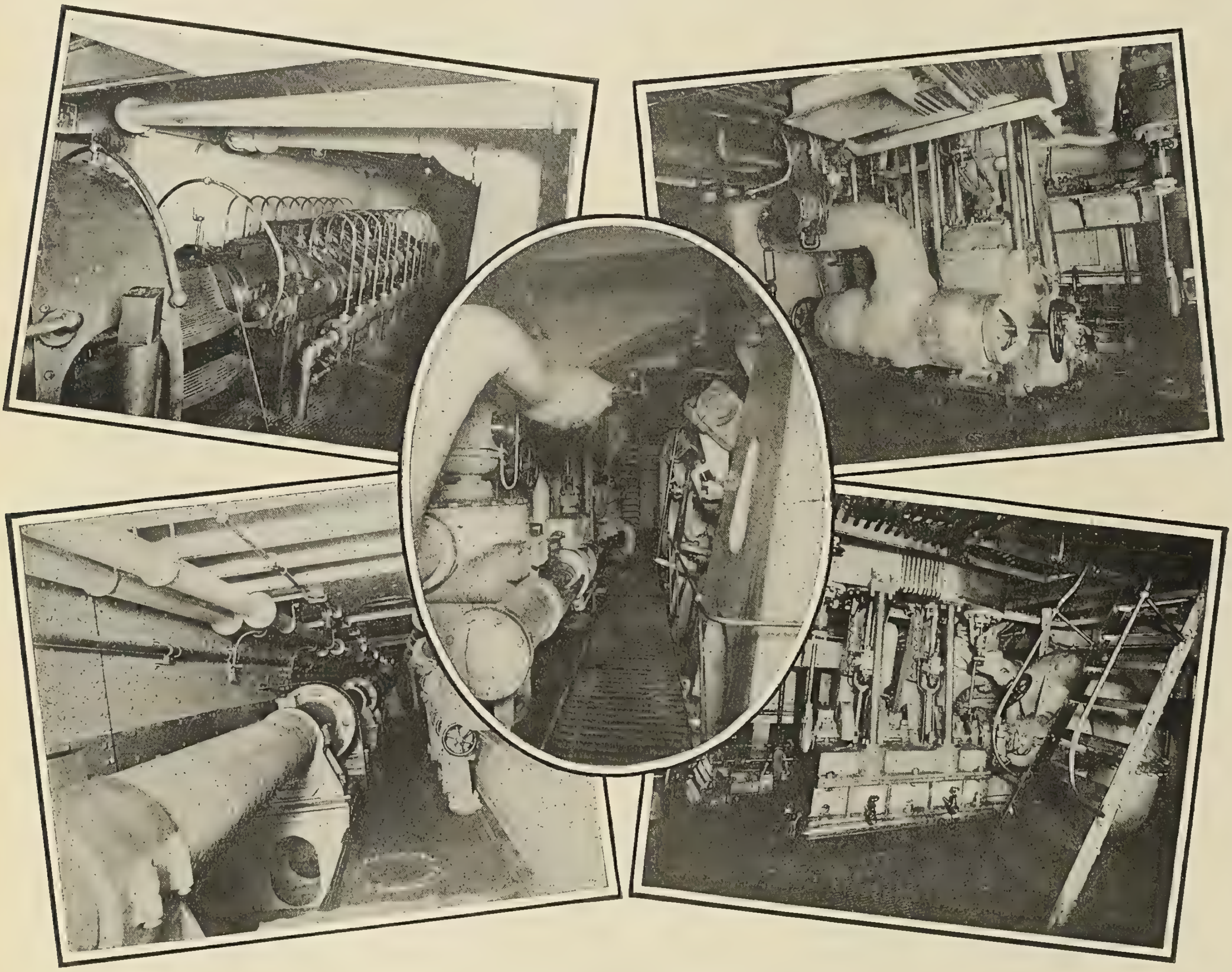
FIG. 7
COMPARISON OF ACTUAL AND CALCULATED CURVES OF RESISTANCE MODELS A TO E

= 1 or more to make the length sufficiently great to obtain the very minimum resistance possible.

While by the use of Figs. 5 or 6 and calculation of the skin friction we can expect to obtain only a rough approximation to the actual resistance of a given vessel, the effect of variation of length for a constant displacement can be investigated with more accuracy; and the length which is most desirable, considering not only the question of resistance but the many other features of importance in this connection, can be determined with a good deal of accuracy.

THE MACHINERY OF THE GREAT NORTHERN STEAMSHIP DAKOTA.

This new 20,700-ton steamer, which was described at some length in our June number, is propelled by two sets of three-cylinder, triple-expansion engines, each designed to develop about 4,800 horsepower, and the entire power being designed to give the ship a sea speed of 14 knots. These engines, which are operated under a steam pressure of 230 pounds per square inch, have cylinders measuring 29, 51, and 89 inches respectively in diameter with a common stroke of 57 inches, and operate at a speed of 78 revolutions per minute. The high-pressure cylinder is fed with steam by one piston valve 17 inches in diameter, the intermediate cylinder by a similar piston valve with a diameter of 32 inches, and the low-pressure by a double-ported slide valve 95 inches wide by 59 inches long; all of these valves having a common stroke of 10 inches. The intermediate- and low-pressure valves are fitted with Joy's assistant cylinders, having diameters respectively of 6 3-4 and 8 3-4 inches, while the high-pressure valve is partially balanced by an enlargement in the diameter of the upper portion.



THRUST BEARING. PUMP PLATFORM. AIR PUMPS.
PORT SHAFT ALLEY. CENTRIFUGAL PUMP.

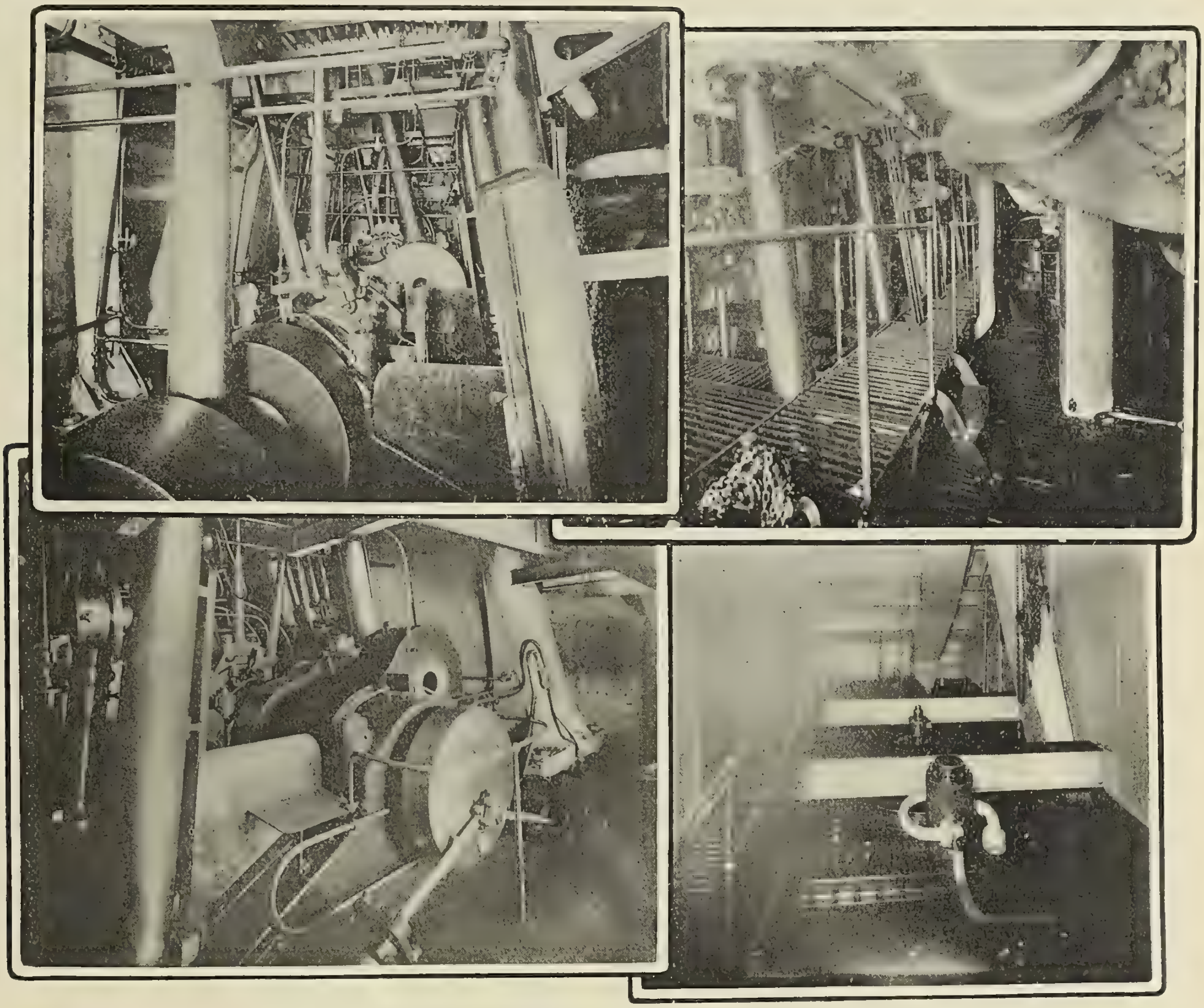
The cylinder castings in each engine are four in number, the low-pressure cylinder and its valve chest being separate castings, while in each of the other cases the valve chest and cylinder are

A New Ship-Repair Yard.

With the arrival in Philadelphia of a section of the floating drydock built at Rondout, N. Y., the beginning of facilities for docking ships in that port has been inaugurated, and it is now anticipated that little necessity will be found for sending ships for docking to Newport News or New York. The dock forms part of the equipment of a new concern known as the Philadelphia Ship Repair Company, which will be located at the foot of Mifflin street. It will ultimately be composed of three sections like the present, each capable of lifting 2,000 tons, and all together capable of taking in a ship of considerable size, it being estimated that the largest vessel now navigating the Delaware river could be lifted in the three.

together in a single casting. The steam opening for the high-pressure cylinder is 11 inches in diameter and steam is drawn in through a steel pipe, while the exhaust opening has a diameter of 15 1-2 inches, and carries the steam through a 15 1-2-inch copper pipe to the intermediate-cylinder valve chest. The intermediate cylinder exhausts through two rectangular passages, each measuring 18 by 12 1-2 inches, while the low-pressure cylinder exhausts through a 32-inch copper pipe into the condenser. All cylinders are steam jacketed, the steam for this purpose being supplied through a 2-inch copper pipe connected with the throttle-valve casing.

an oil cylinder on top, and measures 14 by 7 by 26 3-4 inches. The connecting rods are 10 feet 6 inches long, with a diameter of 10 inches at the crank end and 8 inches at the fork end. The cross-head block measures 13 by 13 inches, with journals 10 inches in diameter and 11 inches long. The slipper, which is of cast steel faced with white metal, measures 24 by 30 inches. The piston rods are 8 inches in diameter in the stuffing box, and taper in the pistons and crossheads to a diameter of 6 inches. Their total length is 10 feet 9 1-8 inches. The pistons are of cast steel and conical in form except for the high-pressure pistons, which are flat and of hollow section in cast iron.



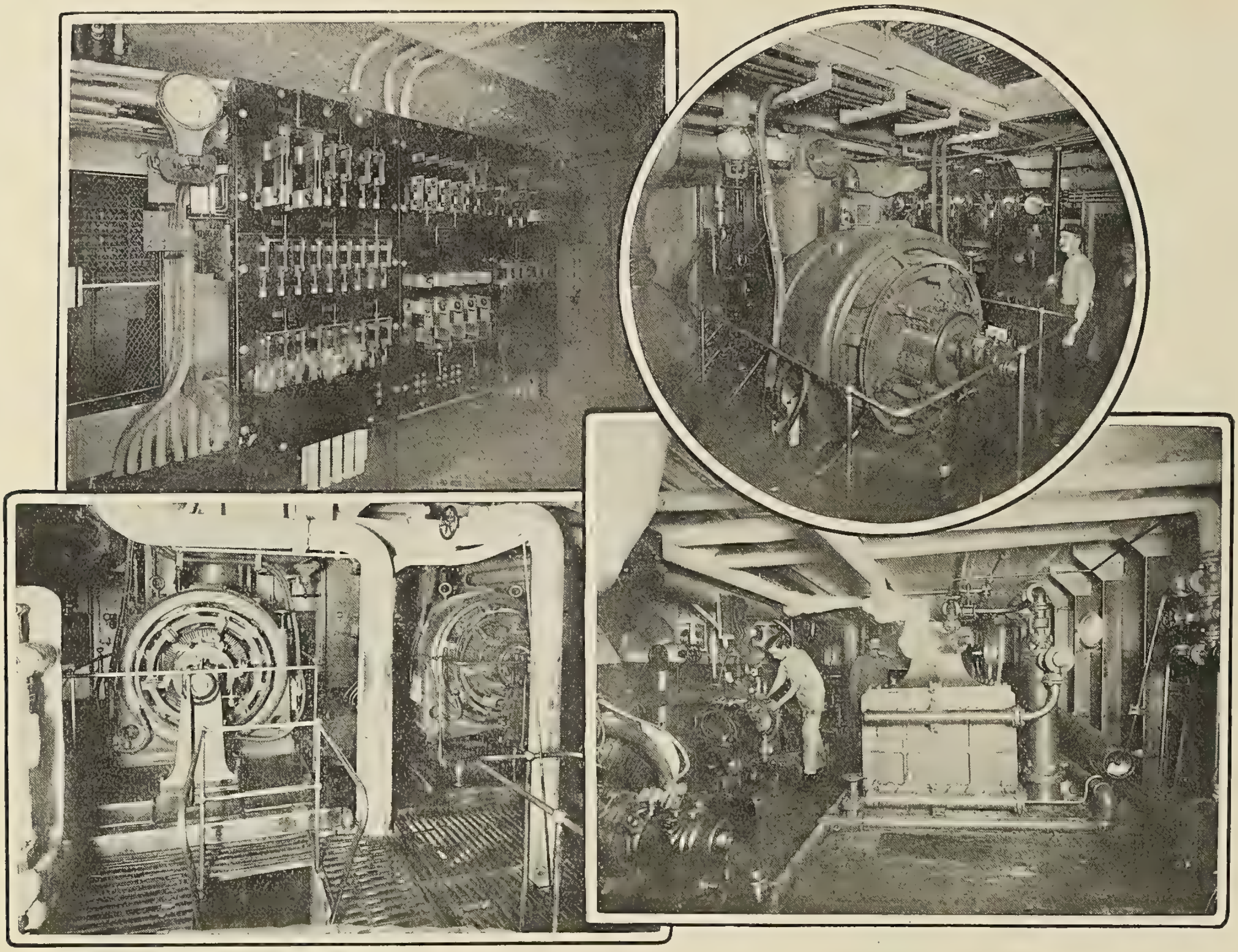
THE MAIN ENGINES OF THE DAKOTA.

The back framing of the engine is of the usual cast iron inverted Y housing, while the front framing consists in each case of six massive steel columns, two for each cylinder. The housings carry the crosshead guides, as well as the gear for handling and governing the engine and for indicating. It has been the intention in designing this machinery to give a maximum of efficiency and endurance at a minimum of weight and cost. With this idea in view the engine framing is of such proportions as to be thoroughly rigid while the engine is in motion, without the use of bracing. The bedplate, which is cast in three sections, is of a very deep box type, the bottom being fitted to the tank top of the ship, to which it is firmly bolted.

The main valves are operated by Stephenson link motion with double bar links and eccentric rods measuring 9 feet 9 inches. The reversing gear consists of a direct-acting steam cylinder with

The crank shaft has been built up in three interchangeable sections, each measuring 10 feet 5 1-2 inches in length, the pins and shaft being 18 inches in diameter with 8-inch axial holes. The webs have a thickness of 12 1-2 inches and a width of 37 1-2 inches, their length over all being 66 inches. The couplings are 4 1-2 inches thick and 31 1-2 inches in diameter, and are fastened with nine taper bolts placed on a 25-inch pitch circle and varying from 2 5-8 to 3 3-4 inches in diameter. The thrust shaft, which has a diameter of 18 1-8 inches, is 14 feet 4 inches long and has nine 2 1-2-inch collars with a diameter of 27 5-8 inches. The thrust bearings are of cast iron lined with white metal, each shoe having water circulation, besides which the collars run in oil.

Each of the two three-bladed propellers is a true screw with detachable blades, and has a diameter of 20 feet, a mean pitch of 22 feet 6 inches, a developed surface of 98.7 square feet, and a

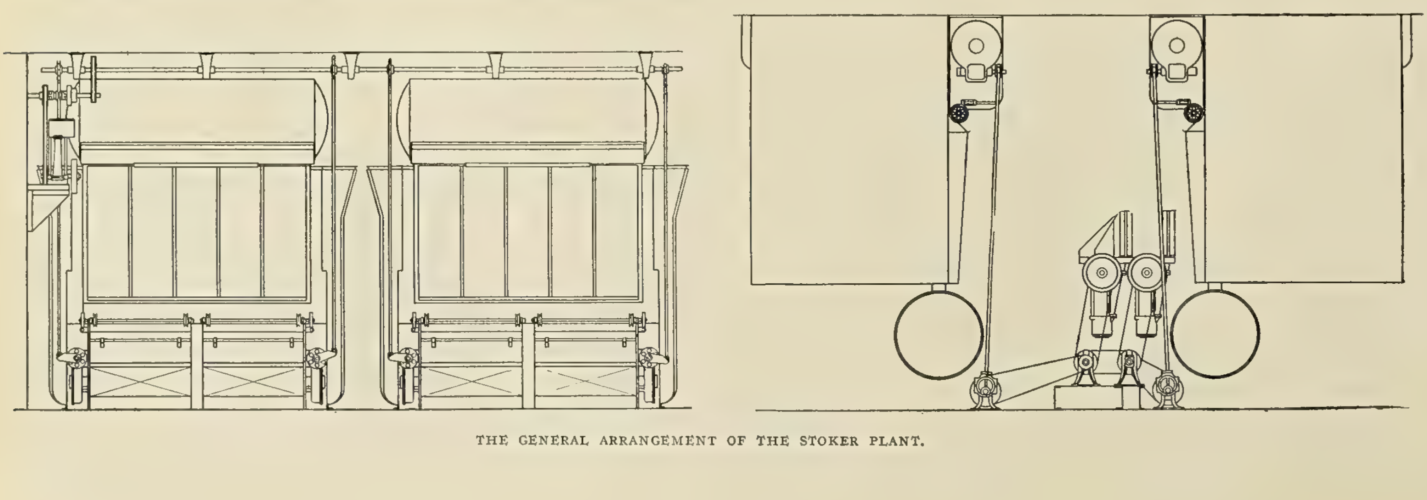


SWITCHBOARD IN CENTRAL STATION.
THE WESTINGHOUSE GENERATORS.

THE WESTINGHOUSE GENERATORS.
THE REFRIGERATING ENGINE ROOM.

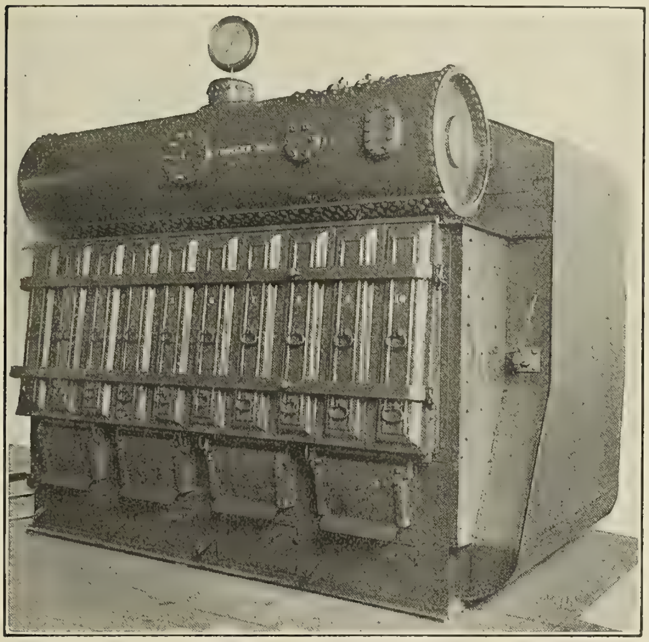
projected surface of 81.6 square feet. The blades are fastened to the hubs by nine steel studs each, with oval holes allowing a range of pitch adjustment from 21 feet 6 inches to 23 feet 6 inches.

Steam is furnished by a battery of sixteen Niclausse water-tube boilers placed in groups of four in each of four fire rooms. One of these groups has been fitted experimentally with Duluth automatic stokers, manufactured by the Whiting Foundry Equipment Company, of Harvey, Ill. These stokers consist of an endless belt of grate bars carried by two endless chains, one operating on each side of the furnace. The rate of progress of these grate bars through the furnace is given as 7 1-2 inches per minute. The back end of the stoker is adjustable vertically, so that the space between the grate bars and a cross water box above them may be regulated to suit the various sizes of clinkers resulting from the combustion of various kinds of coal. The water box prevents the unconsumed coal on top of the fire from being dropped into the ash pit, and also prevents the ingress of cold air between the grate bars and its own position. A small independent engine is installed to drive each of two sets of these stokers on opposite sides of the engine room. The body of the stoker is composed almost entirely of structural steel, the driving gear being inclosed in an



THE GENERAL ARRANGEMENT OF THE STOKER PLANT.

oil-tight and dust-proof casing, and a regulating device fitted for stopping the stoker, or for permitting a number of changes in speed, as may be required.



ONE OF THE NICLAUSSE BOILERS.

The boilers on the *Dakota* were made by the Stirling Company, and are duplicates of those on the *Minnesota.* Six of them are provided each with fifteen elements, two with seventeen, four with eighteen, and four with nineteen elements. Each element is made up of a malleable-iron header and twenty-four 3 1-4-inch tubes. The total heating surface in the sixteen boilers is 40,600 square feet, the grate surface hand fired being 811 square feet and with stoker firing 305 square feet. This gives a total ratio of heating surface to grate area of 36.4 to 1. The steam drums are made of steel plate 15-16 inch thick.

In addition to the natural draft furnished by the stacks, induced draft is provided for, and air heaters are fitted above each boiler. The gases are drawn through these air heaters by the induced draft fans, the air passing through ducts at the side of the boiler to the ash pits. By this arrangement it is heated to a temperature above 300 degrees Fahrenheit.

The Great Naval Battle of the Sea of Japan.

Contrary to general expectation, Admiral Togo fought a pitched battle with the Russian fleet under Admiral Rojestvensky on the afternoon and evening of May 27, and the engagement was continued throughout almost the entire day following. This battle was fought in the Korean Strait, between the Tsu Islands and the main Japanese group, in territory of Togo's own choosing, and appears to have been characterized at the start by a considerable element of surprise for the Russians, who had not expected to meet the enemy in such force at that point. The result, as all the world knows, was almost a complete annihilation of the Russian fleet, only four unarmored cruisers and a couple of destroyers having escaped either destruction or capture.

The Russian fleet consisted, according to the best available information, of the eight battleships *Kniaz Suwaroff, Orel, Borodino,* and *Emperor Alexander III,* of 13,516 tons each, *Oslabya* of 12,674 tons, *Navarino* of 10,200 tons, *Emperor Nicholas I* of 8,440 tons, and *Sissoi Veliki* of 8,800 tons; the three coast defense ships *Aphraxine, Oushakoff,* and *Senjavin,* of 4,126 tons each; the three old ironclads, now called armored cruisers, *Admiral Nachimoff* of 8,520 tons, and *Vladimir Monomach* and *Dimitri Donskoi* of 5,800 tons each; the six protected cruisers *Aurora* and *Oleg* of 6,650 tons each, *Svietlana* of 3,828 tons, and *Jemtchug, Almaz,* and *Izumrud* of 3,100 tons each. This makes a total of twenty war vessels, with a displacement of 153,104 tons. In addition to this force there are stated to have been in the Russian fleet thirteen torpedo destroyers, six auxiliary cruisers, five volunteer steamers, one tank steamer, the repair ship *Kamschatka,* and two hospital ships. The batteries carried by the twenty war vessels in this fleet included twenty-six 12-inch guns, seven 10-inch, four 9-inch, eight 8-inch, one hundred and twenty-six 6-inch, fifty-two 4.7-inch, and one hundred and thirty-four 3-inch guns.

Of this fleet, all of the battleships were sunk except the *Orel* and the *Emperor Nicholas I,* which were captured. The coast defender *Oushakoff* was sunk and the other two captured. All three of the armored cruisers were sunk. The *Jemtchug* and *Svietlana* were sunk, the *Almaz* and one torpedo destroyer escaped to Vladivostok, while the other three protected cruisers reached Manila, and have there been interned. A number of the special service ships have reached Shanghai or other Chinese ports, and will probably be held in those ports until the end of the war.

The Japanese fleet, which wrought this tremendous destruction, consisted of the four first-class battleships *Asahi, Mikasa, Shikishima,* and *Fuji Yama;* the second-class battleship *Chin Yen,* captured from the Chinese in 1894; the eight armored cruisers *Asama, Adzuma, Idzumo, Iwate, Kasuga, Nisshin, Tokiwa,* and *Yakumo;* besides a considerable number of protected cruisers, comprising nearly all of that type of ship in the Japanese navy. If the entire sixteen protected cruisers which the Japanese had in service were engaged in this battle, the fleet numbered thirty, with a total displacement of 198,470 tons. The combined batteries contained in this case three 12.6-inch, twenty 12-inch, one 10-inch, thirty-six 8-inch, two hundred and two 6-inch, one hundred and seventeen 4.7-inch, four 3.5-inch, and one hundred and seventy-two 3-inch guns.

There is no thoroughly satisfactory method of comparing these two fleets, even when we leave out of account the entirely elusive element of the personnel. A writer in *L'Illustration* has made a tentative comparison, basing his results upon a combination of displacement, horsepower, artillery, armor, and another item which is sub-divided between crew and proximity to naval base. To each of these five items he gives a maximum credit of 20 points, and figures that the Japanese possess this maximum in every case except horsepower, where they are given a grade of 18. This gives them a total of 98 points. In the Russian fleet full credit is given to horsepower, a mark of 18 to both displacement and armor, 18 1-2 to artillery, and 14 1-2 to the last item, making a total of 89. This ratio of 98 to 89 is thus given as the relative paper efficiency of the two fleets.

With the very uncertain element always entering into a proposition of this sort by reason of the presence or absence of torpedo craft, both surface and submerged, any method of getting at results from a mere comparison like the above is necessarily futile, the more so when we consider the fact that from published results to date a considerable number of the Russian ships met their fates by being blown up by submerged mines, or in some other manner entirely independent from the usual operation of ship against ship. If it had been a question of gun power only, which such a pitched battle usually implies, the advantage would have been somewhat with the Japanese by reason of the great preponderance of guns of 6-inch and 8-inch caliber possessed by their ships, notably by the splendid fleet of armored cruisers which they had in the battle.

Evaluating this on a purely arbitrary basis, allowing certain values per gun for all guns above 3 inches in caliber, the total value of those carried by the ships engaged was computed, and this result then affected by a coefficient indicative of the speed of the ship on which these guns were carried, the protection afforded the guns, and the age of the ship. By following out these processes the Russian guns figured out at 1,429 as compared with 1,726 for the Japanese, which figures may be taken as fairly representative of the relative artillery power on paper of the two squadrons. They do not, however, take account of the splendid marksmanship shown by the Japanese and the wretched gunnery of their opponents, which appears to have been merely another case of Manila Bay and Santiago.

By the addition to their fleet of the four captured ships, the *Variag* from Chemulpo, and possibly one or two from Port Arthur, the Japanese will end the war with a navy equal to that with which hostilities were begun, while that of their opponent has been almost entirely destroyed. There still remain to Russia several battleships locked up in the Black Sea, three large ones building on the Baltic, half a dozen cruisers and small battleships in European waters, three or four cruisers at Vladivostok, and the various ships interned at points ranging from Chefoo to Manila.

THE LAUNCH OF KASHIMA, SHOWING BITS OF PAPER FLOATING AWAY FROM STARBOARD BOW.

The New Japanese Battleship Kashima.

The accompanying illustration shows the launching of the Japanese battleship *Kashima,* at the Elswick yard of Sir W. G. Armstrong, Whitworth and Company, Limited, which occurred on March 22, 1905. This battleship has a length of 425 feet and a breadth of 78 feet, the depth being 43 feet 6 inches and draft 26 feet 7.5 inches. The displacement is 16,400 tons. She is equipped with engines of 15,600 indicated horsepower, and is designed to operate at a speed of 18.5 knots. The normal coal supply is 750 tons, while the bunker capacity is 2,150 tons. The main propelling machinery consists of twin-screw, four-cylinder, triple-expansion engines, with cylinders measuring 36, 56, 63, and 63 inches in diameter respectively, and a stroke of 48 inches. They were constructed by Humphreys, Tennant & Company, of London, and are supplied with steam from twenty Niclausse boilers installed in three separate boiler rooms.

The launch of this powerful battleship is of great interest when it is considered that she has penetrating powers at 3,000 yards which no armor on any ship afloat could hope to withstand. The armament consists of four 12-inch and four 10-inch rifles of great power, twelve 6-inch rapid-fire guns, twelve 12-pounder and three 3-pounder rapid-fire guns, as well as six Maxim guns, and five 18-inch submerged torpedo tubes.

The armor of the *Kashima* includes a belt from 9 inches to 4 inches in thickness, and a citadel of 6 inches, together with a 9-inch conning tower and 5-inch observation tower. The upper deck screen armor is 4 inches in thickness, and the 12-inch gun barbettes are 9 inches and 5 inches, while the 10-inch gun barbettes are 6 inches and 2 inches, making a most complete and almost impregnable protection.

The *Kashima* is the best battleship in the Japanese navy, holding a position in advance of any of the others as regards armament, hull and engines. Her speed of 18.5 knots per hour is in harmony with all other Japanese ships of the same type. To give some idea of the enormous aggregate power of the guns to be employed on the *Kashima,* it may be of interest to note that they were designed to be able to throw an effective weight of some eleven tons of steel per minute.

Kashima, the name given to this battleship by the Emperor of Japan, was that of one of his heroic ancestors whose shrine is situated in the province of Kashima, some fifty miles from Tokio.

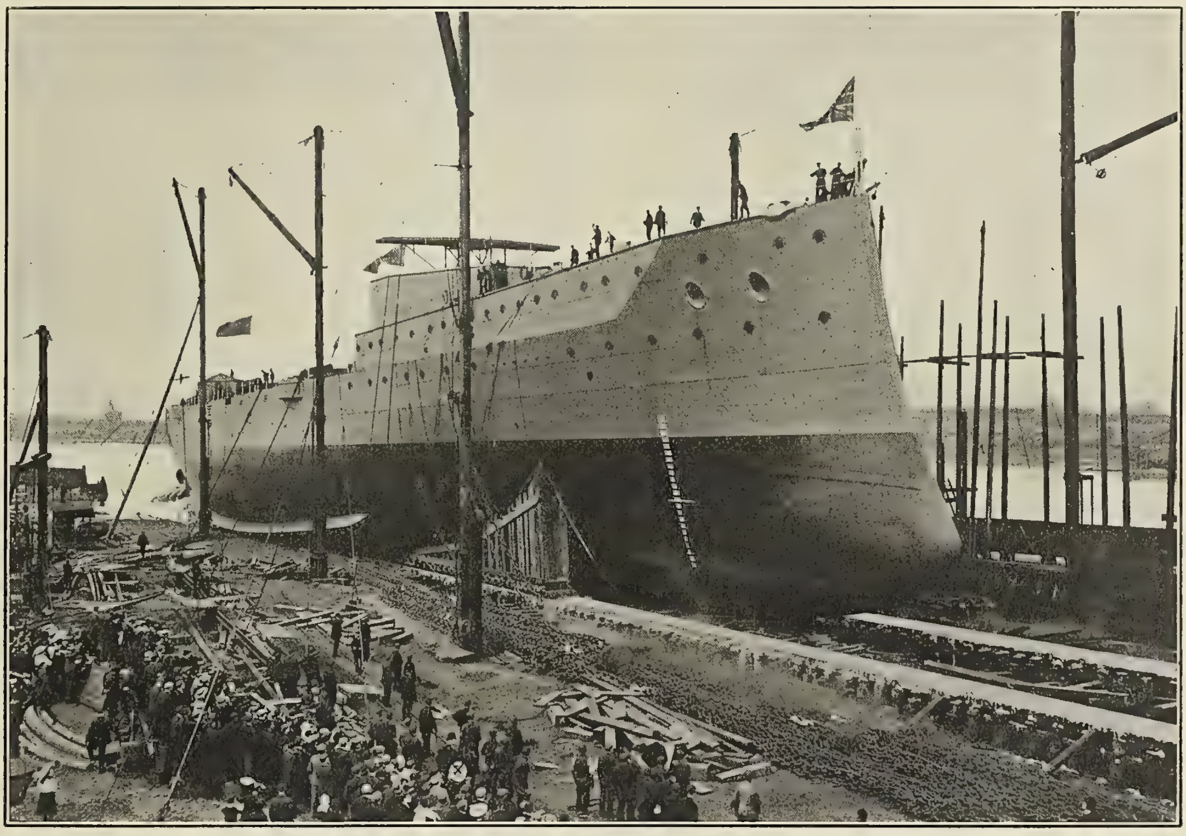
It is also the name of one of the gods of war, the "Brother God Katori," whose temple is also situated in Kashima, but whose real history, dating back some 3,000 years before the first emperor, is not well known.

The Elswick shipyard, where the launching took place, is one of the greatest in England, some of the largest battleships having been constructed there during the past two decades. Their records show that since 1884 they have been responsible for the production of no less than 73 war vessels, representing almost every type, and constructed for fifteen different navies of the world. The displacement reaches a total of about 296,000 tons, and the aggregate horsepower of the machinery with which they have been provided is 672,000. Of these 73 warships 14 have been constructed for Japan and 21 for England; but the total tonnage of the British vessels amounts to just over 86,000 tons, while that for the Japanese navy is 105,000 tons, or 34 percent of the total of 296,000 tons. In the Japanese fleet at the commencement of the war were all these vessels, including the 17-year old cruiser *Idzumi*, originally the Chilian cruiser *Esmeralda*, and the fast protected cruiser *Yoshino*, which had previously taken part in the war with China, and was one of the ships lost during the operations before Port Arthur.

the Fairfield Company. These are designed to work at a pressure of 210 pounds, and to give sufficient steam to allow the engines to develop 23,500 horsepower, with which it is expected that a speed of 23 knots will be obtained. The normal supply of coal is 1,000 tons.

The armor protection of the *Cochrane* consists of a water-line belt 6 inches in thickness amidships, tapering to 2 inches forward and 4 inches aft. The protective deck, which extends from stem to stern, ranges in thickness from 3-4 inch to 2 inches; while a second deck of 1-inch armor forms a crown for the side armor and armor bulkheads. The battery, which is an unusually heavy one for a ship of the cruiser class, contains six 9.2-inch and four 7.5-inch rifles operating on the rapid-fire principle, while the secondary battery consists of twenty-eight 3-pounder rapid-fire guns and two 12-pounder boat guns, as well as two Maxim guns and three submerged 18-inch torpedo tubes.

The beautiful lines of this ship are shown in the accompanying photograph of the launch, the splendidly clear-cut bow in particular being noticeable. It is expected that these ships will prove the most efficient vessels of their class afloat, not only in speed and general seaworthiness, both of which are largely aided by the high forecastle, but also in maneuvring qualities and in



THE LAUNCH OF THE COCHRANE.

The Armored Cruiser Cochrane.

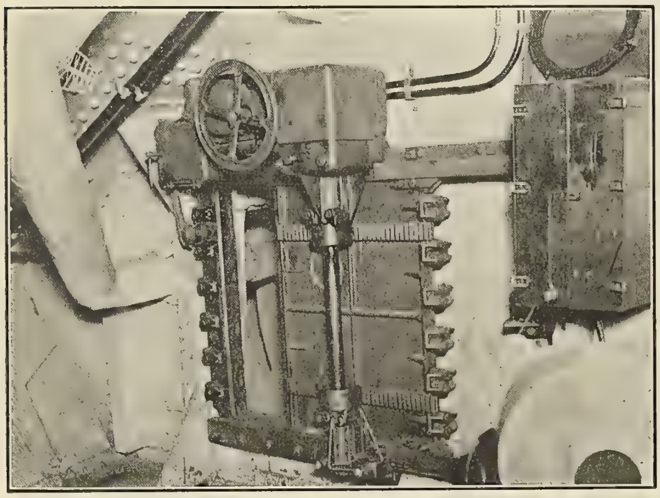
One of the finest armored cruisers afloat was put into the water May 20, 1905, by the Fairfield Shipbuilding and Engineering Company, Limited, of Govan, Scotland. This ship, which is one of the class first designed by Mr. Philip Watts when he succeeded Sir William White as Director of Naval Construction for the British navy, has a length of 480 feet, a beam of 73 feet 6 inches, and displaces at load draft 13,550 tons. The propelling machinery consists of two sets of triple-expansion engines having each four cylinders, and supplied with steam by nineteen Yarrow watertube boilers and six single-ended cylindrical boilers, all made by

battery power. It will be noticed that none of the main battery guns has a smaller caliber than 7.5 inches, and the broadside, which consists of four 9.2-inch guns and two of 7.5-inch caliber, is superior in striking power at long range to anything which could be brought to bear against it by any other cruiser of the same general type. This is readily seen by reference to the broadside of the American cruisers of the *Maryland* class, which consists of four 8-inch and seven 6-inch guns, and which at a range of more than two miles might be said to consist of four 8-inch guns only, so far as any attack on armor of more than four or five inches in thickness is concerned. We are indebted for the photograph to Mr. Allan McPherson, Jr., of Glasgow.

BULKHEAD CONSTRUCTION ON WARSHIPS.

Several things have given current prominence to the subject of bulkhead construction in warships: the report that the British Admiralty contemplated the abolition of watertight bulkheads; the lessons of the naval engagements in the Far Eastern war; and some important changes in the interior design of warships.

As to the report that British naval authorities are considering the abolition of watertight bulkheads, it may be said on good authority that there is not the slightest foundation for the various rumors to this effect which have gained currency in the past few months. It appears that those who have been responsible for the reports referred to, are not only entirely misinformed as to the Admiralty's intentions, but have too slight a knowledge of the subject to realize the absurdity of the statements they have put forth. The English naval expert, Mr. Herbert Russell, disposes of these statements with the remark that "To credit the Admiralty with the intention of abolishing the one great safe-guarding condition of stability at a time when its value was never so great, owing to the development of the modern methods of warfare, would be simply ludicrous were it not that a certain element of mischief lurks in such irresponsible tales."

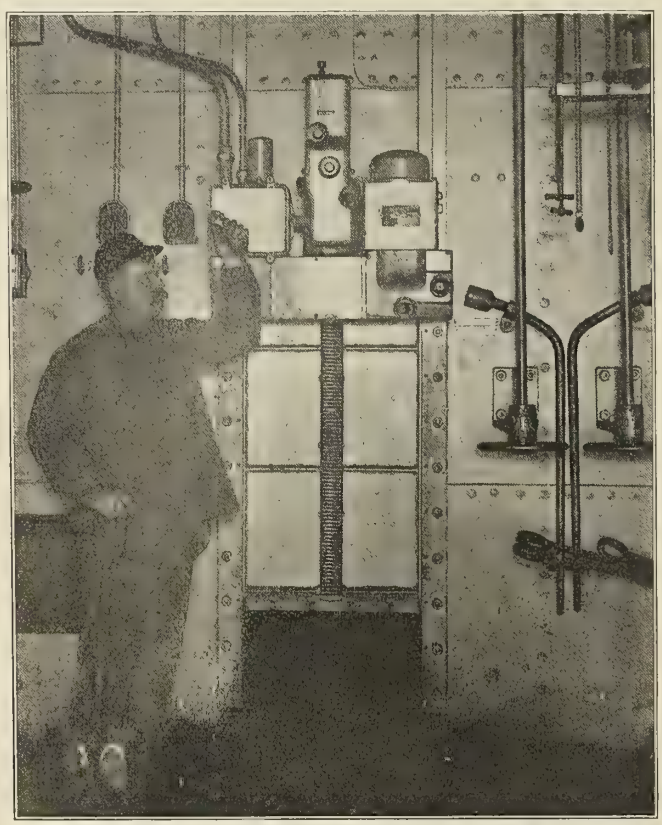


HORIZONTAL BULKHEAD DOOR ON U. S. S. COLORADO.

So far as can be discovered the sole basis for these tales is that the construction department of the British navy has had under consideration for some time past, certain modifications in bulkhead design. But these modifications refer principally to armored doors, which have long been recognized as the greatest source of weakness in the interior walls of steel with which the modern warship is fitted. The number of doors is to be reduced to as few as shall be consistent with ready communication between the different parts of the ship, and a new pattern of door is to be introduced, consisting of either vertical or horizontal sliding armor plate, opened and closed by mechanical means. While these statements are made on good authority, they can be offered only as representing the intentions of the British Admiralty so far as they have been fixed at the present time, and these intentions are, of course, subject to modification. It is true that the old pneumatic and hydraulic systems of power doors did not give satisfaction, and their admitted faults and deficiencies are perhaps responsible for the prejudice which lingers in the minds of some British naval authorities against the power door. Here, the development of bulkhead power doors has called electricity to aid in the solution of the problem, while the hydraulic-pneumatic system installed on some foreign ships is substantially the same as that abandoned by American designers in favor of electricity.

THE "LONG-ARM" SYSTEM.

Recognizing the supreme importance of the bulkhead-door problem, British naval authorities have watched with a great deal of interest the progress of the installation on United States warships of the "Long-Arm" system of power doors and hatches. English naval and technical journals have paid a great deal of attention to the design and operation of this system, and several of these organs are urging the desirability of adopting the same system for the warships of the British navy. Without going into the details of the system, it may be said that it consists of power doors and hatch plates each provided with electrical motors and connected by electrical conductors with a central emergency station located above decks. It is possible to close all the doors and hatchways so connected by starting the mechanism of the emergency station. Hand-levers on both sides of the door secure local control when the emergency is on, and a limit switch gives security against the blowing out of fuses in the event of the doors encountering an obstacle as they come to a close. The emergency station is provided with an indicator which shows at once whether or not all the doors or hatchways under control have shut, and a diagram numbered to correspond with the numbers of the doors enables the officer in charge to ascertain immediately the location of any trouble. This system is now installed on eighteen ships, and thirteen more are to have the same equipment.

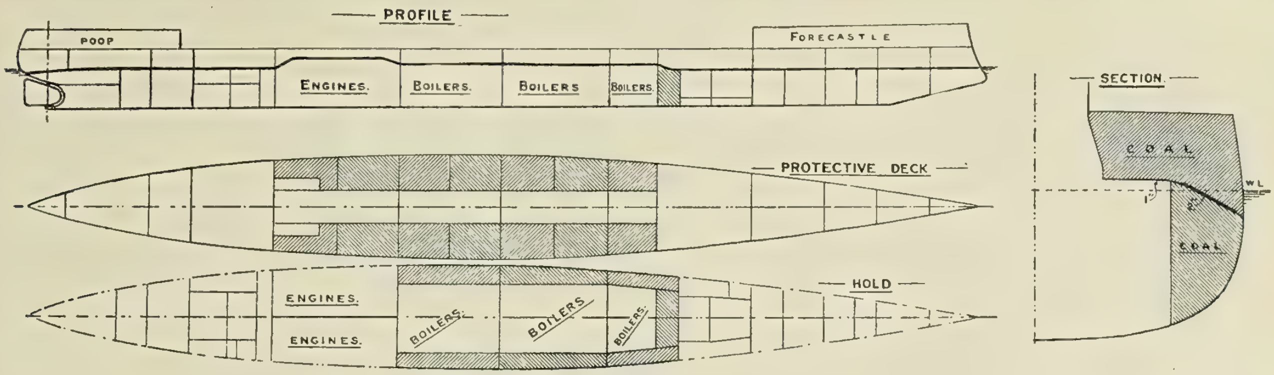


VERTICAL BULKHEAD DOOR ON U. S. S. COLORADO.

The door can be operated by hand lever while emergency is "on."

LESSONS OF THE FAR EASTERN WAR.

As to the lessons of the Far Eastern war, these are somewhat different from the public impression in regard to them, so far as bulkhead construction is concerned. Several times Russian ships were torpedoed by the Japanese, and many of these ships sank after greater or less intervals of time. In most cases, however, the damaged ship did not sink—she merely settled—thus giving direct testimony to the value of the watertight bulkhead. Without these bulkheads every Russian ship which encountered a Japanese mine or was torpedoed, would have gone to the bottom at once. As a matter of fact, nearly all the ships under which mines and torpedoes were exploded managed to escape, even though seriously damaged.

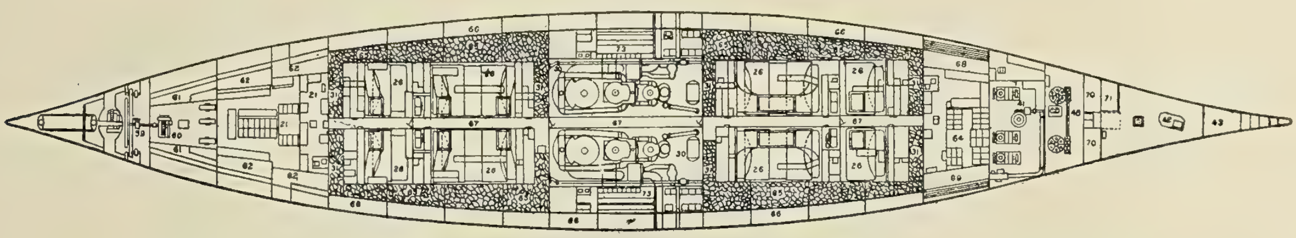


WATERTIGHT SUBDIVISIONS OF A THIRD-CLASS CRUISER.

(From Attwood's "Warships.")

The lessons, then, of the naval warfare in the Far East cast discredit neither upon the torpedo nor the watertight bulkhead. They confirm the long-standing belief of naval engineers that if it were practical to divide a war vessel into a sufficient number of watertight compartments, the torpedo would, indeed, be rendered impotent; but for various reasons it is impossible to multiply the number of bulkheads. One of these reasons is involved in the question of weight.

If, however, the unsinkable ship is unattainable because the present means to that end, if extended, would impair stability, it does not follow that no further progress in this direction is to be looked for. Changes in warship design, all in the way of progress, are constantly going on—so constantly indeed that it is difficult to keep pace with them. The latest news is that the Board of Naval Construction intends to make important changes in some of the ships now building. Heretofore the construction of a ship after the general board recommended its tonnage, battery, and speed, and the Board of Construction passed the plans, has been entirely under the direction of the Bureau of Construction and Repair and the shipbuilders to whom the contract was awarded. Officers of the line, upon whom devolves the duty of commanding the ship, have had, from the time the craft was laid down until it was commissioned, little to do with its construction. But now the period of change is to be extended to cover almost the whole life of a warship on the ways, and the men who fight our warships are to have more to say about their design and equipment.

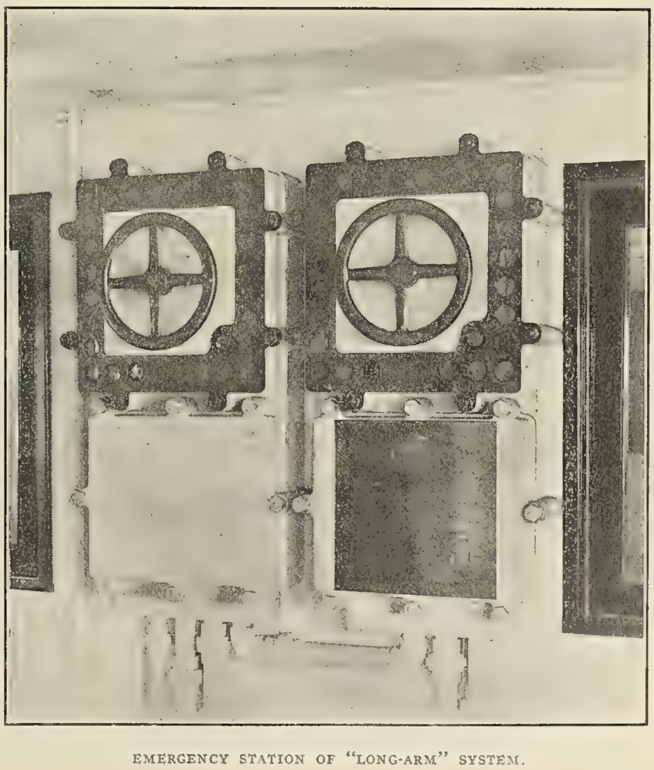


SUPERIOR HOLD OF JAPANESE CRUISER KASUGA.

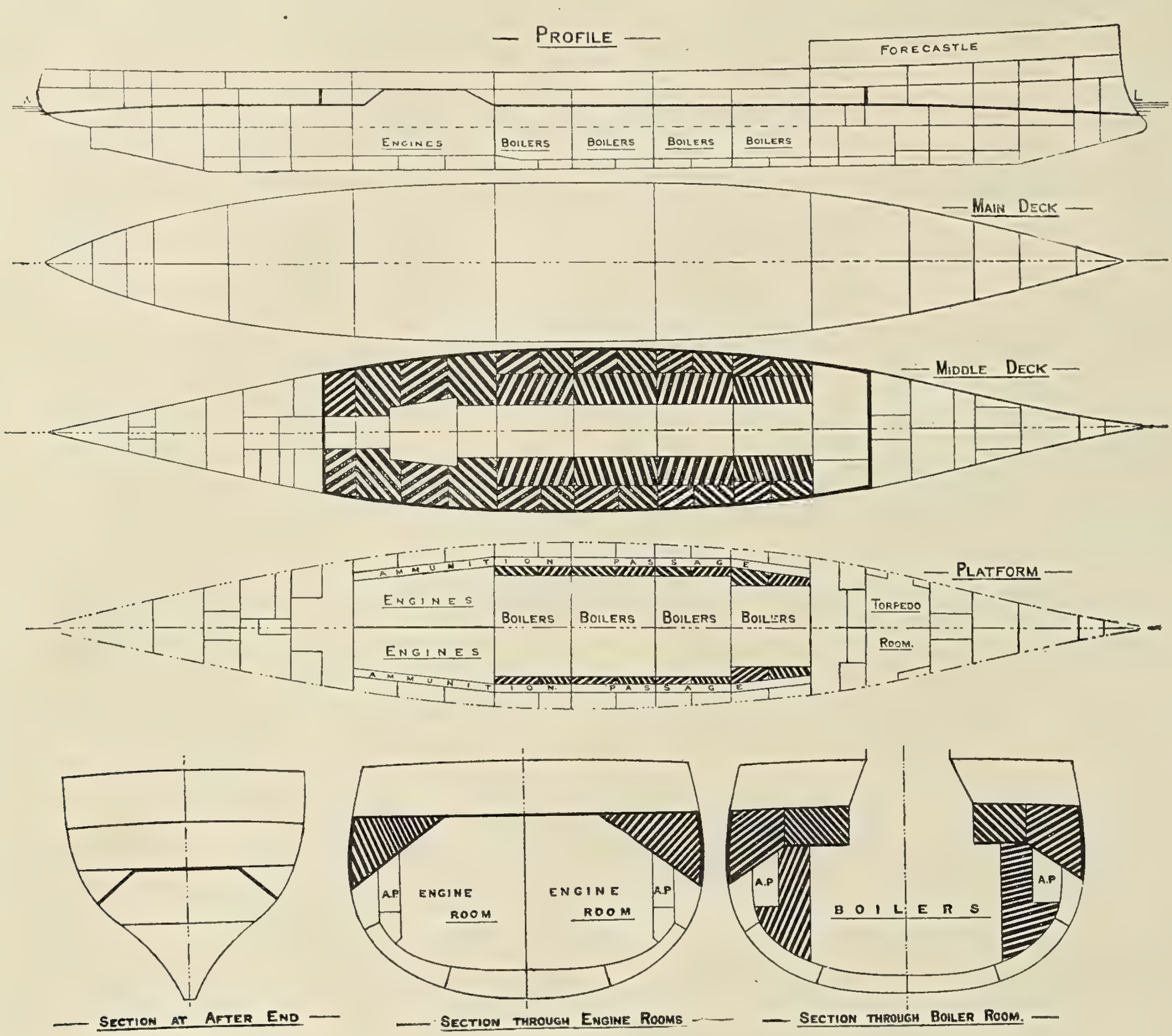
FUNDAMENTALS OF BULKHEAD CONSTRUCTION.

It is possible, notwithstanding these incessant changes, to state in outline the fundamentals of bulkhead construction and the main methods of the watertight sub-division of a ship. The latter are: (1) A watertight inner bottom. (2) A watertight deck. (3) Transverse bulkheads. (4) Longitudinal bulkheads. In smaller vessels the double bottom is often dispensed with on account of the space it occupies.

The transverse bulkheads—watertight partitions extending across the ship—vary in number. The diagrams herewith show their number and arrangement in a first- and third-class cruiser. The bulkhead nearest the bow and extending to the upper deck, is the collision bulkhead, and has probably saved more ships than all the other bulkheads put together. According to the latest practice, no openings of any kind are allowed in this bulkhead. In some cases an additional bulkhead is erected from three to five feet abaft the collision bulkhead, with a view to preventing the inflow of water in case the collision bulkhead should be damaged. The transverse bulkheads between the engine and boiler rooms are



EMERGENCY STATION OF "LONG-ARM" SYSTEM.



WATERTIGHT SUBDIVISIONS OF A FIRST-CLASS CRUISER.

(From Attwood's "Warships.")

usually specially constructed, both on account of their importance and because of the additional stiffening required for a large area and depth of unsupported plating. The governing feature in the construction of all bulkheads is the area of unsupported plating likely to be exposed to water pressure.

Bulkheads forming the fore end of the forward boiler room and the after end of the engine room do not require the extensive stiffening applied to the divisions between the engine and boiler rooms, because the former receive support from decks and platforms. In between the main transverse bulkheads, divisional bulkheads are placed in the upper and lower side bunkers, and beneath the watertight flat in the upper bunkers of battleships an additional set of bulkheads is fitted, thus providing for the most minute sub-division of the ship in the region of the water-line. It will be noticed in the diagrams that a number of the bulkheads are carried up to the upper deck in view of the possibility of change of trim that might follow puncture of the hull.

LONGITUDINAL PARTITIONS.

A number of longitudinal bulkheads form the boundaries of magazines and other compartments, and thus assist in maintaining the watertight sub-division. Their small area makes massive construction unnecessary. Only the four principal fore-and-aft bulkheads need be described. These are: (a) The middle line engine-room bulkhead. (b) The inner coal-bunker bulkhead. (c) The outer coal-bunker bulkhead, and (d) the upper coal-bunker bulkhead. All of these are plainly shown in the diagram of the bulkhead system of a first-class cruiser. In smaller ships the two bulkheads last mentioned are sometimes omitted in order to increase the coal-carrying capacity and to make handling of coal easier.

The engine-room bulkhead extends the whole length of the engine room, and is carried up to the main deck. On account of the strain which would come upon it in case one engine room was flooded, this bulkhead is constructed as carefully and heavily as the main transverse bulkheads.

The inner coal-bunker bulkhead is supported by the divisional bulkheads in the bunkers, and the outer coal-bunker bulkhead is virtually a continuation of the inner bottom. It is usual to distinguish the transverse bulkheads by the number of the frame at which they stand. Longitudinal bulkheads are numbered to correspond to the frames at which each begins and ends. Bulkhead 100 to 120 would thus be the one extending between the frames bearing the same numbers.

THE CENTRAL TUNNEL.

In connection with this subject there are points of interest in the new Italian-built Japanese armored cruisers *Kasuga* and *Nisshin*. The central position of the engines, with the corresponding disposition of armament, dictated to a great extent the structural arrangement of the ships, which is, however, on the whole, the same as is usual in ships of their size and class, with the exception of a central tunnel running along the middle line of the ship close underneath the armor deck, and between and above boilers and engines. The idea of such a tunnel was taken from English warships, which had a similar central passage. But while in the British ships the side bulkheads of the tunnel went down to the inner bottom and formed magazines below, the Japanese ships, failing the necessary space below, are contented with the tunnel above, which, as in the English ships, was intended as a thoroughfare for easy communication between the various machinery compartments, for easy and accessible passage of electric wires, speaking-tubes, telegraphs, for the maneuvring of the main drainage valves, etc., and for eventual conveyance of ammunition from end to end, should necessity occur. This last utilization was, however, subsequently discarded, the tunnel being shut at the ends, with no communication with the ammunition compartments. The tunnel is supported in the engine rooms by the central longitudinal bulkhead which separates the two engines, and by pillars in the boiler rooms, in two rows along the central longitudinal passage between the boilers.

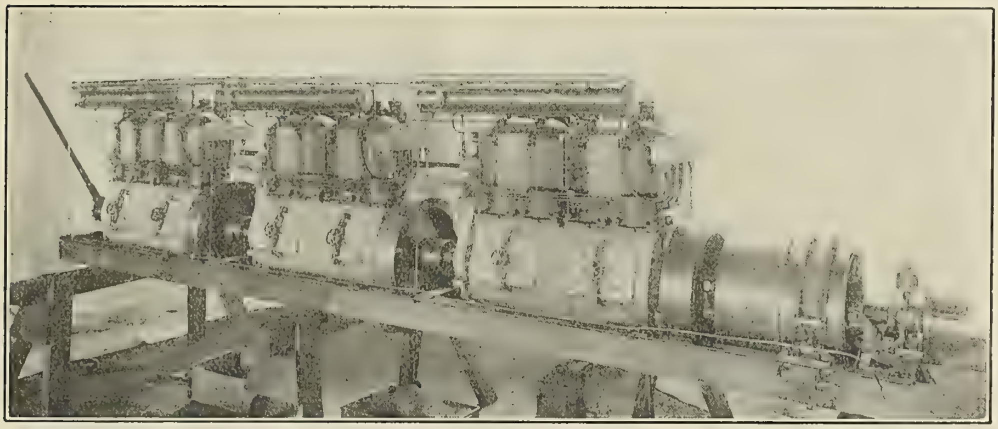
In addition to the usual cofferdams around the hatchways of the protective deck, a cofferdam about 30 inches wide was built at the side of the Japanese ships from the protective deck to the main deck, to allow leakages to be stopped at the sides and the slopes of the armor deck to be cleared of water should damage occur to the armor belt.

We have to record the death, on May 17, of Mr. Edwin McCalla Davis, secretary of the Niles-Bement-Pond Company.

A New Auto Boat.

With hull designed by B. B. Crowninshield, and built by Stearns & McKay, at Marblehead, Mass., a remarkable automobile boat has just been completed by the Winton Motor Carriage Company, of Cleveland, O., which is expected to develop a speed of thirty miles per hour. The length is 40 feet over all, the beam at the water-line 4 feet 3 inches, and the extreme beam 4 feet 8 inches. As shown in the illustration, there is a long turtle back forward, and considerable freeboard, the stern being wide and of relatively low freeboard; but the ship is not of the extreme wedge pattern which has characterized some of the recent racers in European waters. The length of the turtle back is about 25 feet, and the motors will be placed under the after part of it. The frame is extremely rigid for the weight of material used, and no attempt has been made to sacrifice everything for the sake of lightness. The frames are of oak, 5-8-inch square, with fore-and-aft stringers 1 3-4 inches square. The planking is 1-4-inch Spanish cedar, and is so arranged that each seam is backed by one of the stringers, this making a watertight hull without the necessity of calking. The boat weighs 1,200 pounds, and the displacement is about 4,000 pounds.

THE HULL OF THE WINTON RACER.



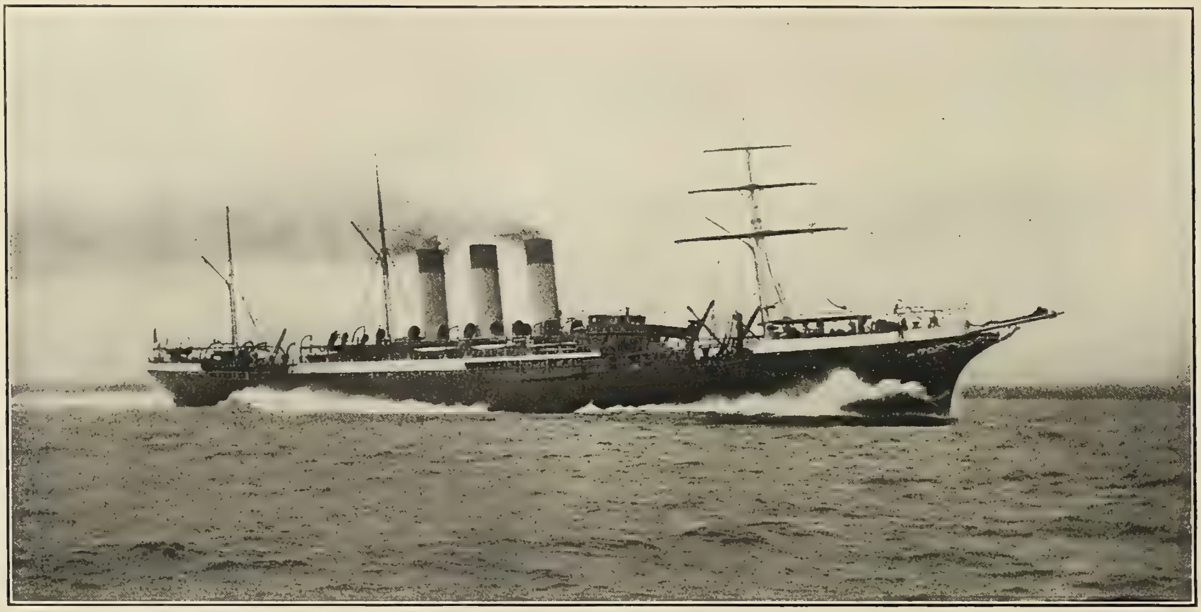
THE TWELVE-CYLINDER ENGINE.

The most remarkable feature of the craft, however, is the 12-cylinder engine, which is designed to develop anywhere from 120 to 150 horsepower. It is composed of three 4-cylinder engines of 40 to 50 horsepower, each of the exact size and character used in model A touring car, the bore of the cylinder being 5 1-4 inches and the stroke 6 inches. The engine is water cooled, the cylinders being cast in pairs with water jackets and exhaust-valve chambers in the same casting. Hand-hole covers on the crank case give immediate access to crank shaft, connecting rods, and pistons.

RUSSIAN VOLUNTEER FLEET STEAMERS.

BY FRANK C. PERKINS.

A number of the Russian volunteer fleet steamers have been constructed in English shipyards, and it may be of interest to note some of the details of construction of the two vessels *Kherson* and *Smolensk*, recently completed at the Hebburn shipbuilding yard of R & W. Hawthorn, Leslie & Company, Limited, of Hebburn-on-Tyne.



KHERSON.

SMOLENSK.

The Russian volunteer fleet steamer *Kherson* is of the twin-screw type, having a length over all of 493 feet. The molded depth of this steamer is 37 feet 3 inches, while the breadth is 54 feet 3 inches. She is fitted with accommodations for 1,480 troops and 72 officers or first-class passengers, and 46 third-class passengers. Provision is made for the mounting of seven 4.7-inch guns. The main engines consist of two sets of the triple-expansion type, having a stroke of 54 inches. The high-pressure cylinder measures 36 inches in diameter, the low-pressure cylinder 92 inches, and the intermediate 57 inches. The steam is supplied from 24 Belleville boilers working at a pressure of 250 pounds per square inch. This fleet steamer has attained, on trial, a speed of 19.5 knots.

The twin-screw transport steamer *Smolensk* was originally designed for trade between Russia and the far east, in time of peace carrying cargo and immigrants, and in time of war being used as a fast cruiser. The total length of the *Smolensk* is 506 feet over all, the depth being 37 feet, and the breadth 58 feet. This vessel is fitted up with cabin accommodations for 1,560 troops and 86 officers, and provision is made on her decks for 18 quick-firing guns and for 10 ammunition magazines on the orlop-deck with steel trunkway leading thereto from the upper deck. She is fitted with electric-fan ventilation throughout; also large steam bread oven, disinfecting plant, and cold-storage rooms, as well as steam laundry, four galleys, and two hospitals. Her water-tight bulkheads are so spaced and strengthened that any two compartments may be in open communication with the sea without the vessel's foundering. The steam suction pipes in the holds are also said to be of a most efficient kind, the pumps being capable of delivering over the side 800 tons of water per hour.

The main engines of the *Smolensk* consist of two sets of the marine triple-expansion type, each having six cylinders, with a stroke 48 inches in length. The two high-pressure cylinders are 26 inches in diameter, the two low-pressure cylinders 75 inches in diameter, and the two intermediate cylinders are 44 inches in diameter. They are so arranged that one high, one intermediate, and one low pressure on each shaft can be thrown out of action when cruising at half power. The engines of this Russian volunteer fleet steamer are supplied with steam from 24 Belleville watertube boilers working at a pressure of 250 pounds per square inch. On trial this vessel has attained a maximum speed of 20.25 knots, and is said to have given excellent service. She escaped into Woosung, the port of Shanghai, after the disastrous naval battle of the Sea of Japan.

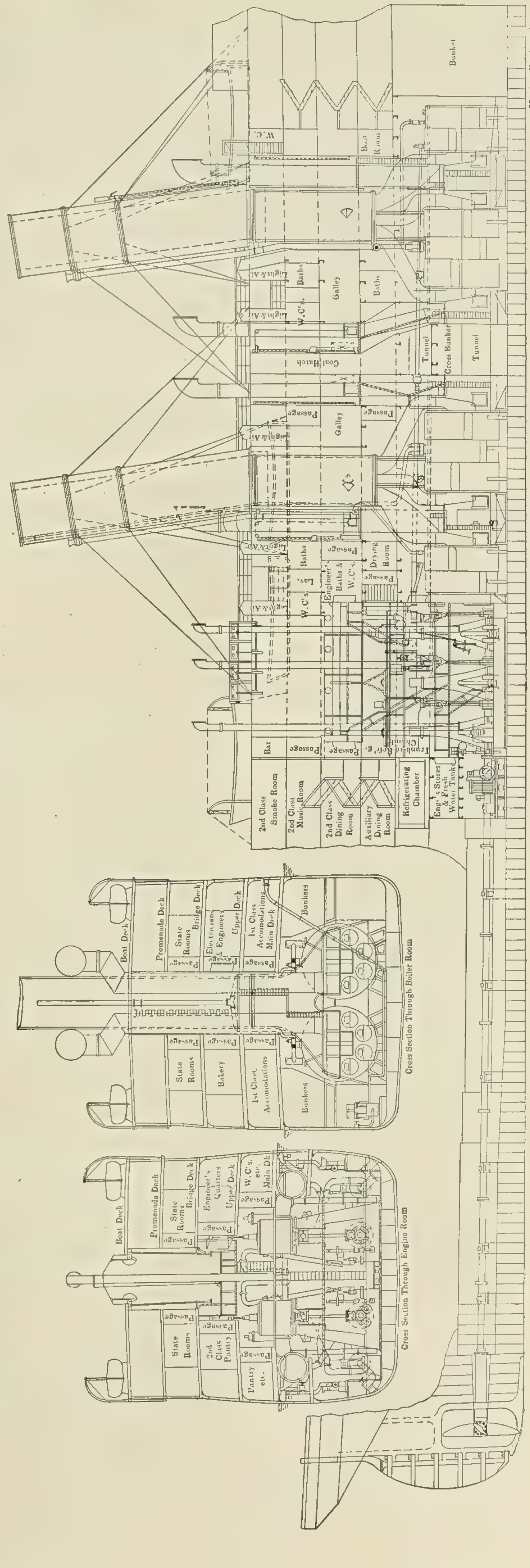
MACHINERY OF THE NEW ANCHOR LINER CALEDONIA.

BY BENJAMIN TAYLOR.

The *Caledonia*, built by D. & W. Henderson Company, of Glasgow, is 515 feet long, 58 feet broad, and 36 1-2 feet deep, and has accommodation for 300 first-class passengers, 400 second-class, and 800 third-class or steerage. Her draft of 27 feet has been limited to enable her to navigate the river Clyde up to Glasgow. The gross tonnage is 9,400, and load displacement 16,000 tons. She is driven by two sets of triple-expansion engines, each set having three cylinders measuring 31 1-2, 51 1-2, and 85 inches in diameter respectively, with a piston stroke of 54 inches.

The cylinders of each engine are rigidly bolted together and stand on six massive cast-iron columns, the front or inner columns being of rectangular section and divided at the bottom for the double purpose of giving fore-and-aft rigidity to the engines, and also, by permitting the cranks to pass between the columns' feet, of providing ample room on the starting platform between the two engines. The back columns are of cylindrical section, with sufficient taper in their length to provide ample area at their bases to ensure stiffness. The sole-plates, to which the columns are securely bolted, are made in three pieces bolted together. They are of hollow rectangular section, and have strong flanges at the bottom for fixing the engines to the top of the ballast tank. The crank-shaft is in three interchangeable parts and is of the built-up type. Each part is carried on two bearings of extra length, lined with white metal. The bearings throughout the entire engines are made with extra large surfaces, so as to ensure efficient working and minimize the possibility of accident.

The cross-head guide plates on the columns are of hollow section, through which an ample cold-water circulation is provided. The air pumps are on Edward's patent system, and are fixed to the back columns of the intermediate engines, from the cross-heads of which the pumps are driven by means of the usual levers; attached to the air pumps, one on either side, and driven by the same cross-head, are two bilge pumps. The condensers are carried on the lower deck beams close to the side of the ship, and quite separate from the main engine structure; the cold-water circulation through them is supplied by two large centrifugal pumps driven by vertical steam engines, and placed on the level of the starting platform between the low-pressure engines and the ship's side, the diameter of the delivery pipe being 16 inches. There are no feed pumps driven direct by the main engines, the whole of the water necessary for feeding the boilers being supplied by two pairs of Weir's feed pumps of large capacity, each pair being sufficient to provide the entire feed water required. There is to each set of pumps a pipe leading from the hot well to a float tank, with automatic control valve. One pump taking the water from this float tank first passes it through an Alley &



SECTIONS THROUGH ENGINE AND BOILER ROOMS, AND INBOARD PROFILE OF ANCHOR LINE STEAMSHIP CALEDONIA.

McLellan Sentinel feed filter, and then into one of Weir's patent direct-contact feed heaters, from which the other pump draws the heated water and delivers it through the main line of feed pumps to the boilers.

To ensure the rapid manipulation of the main engines in narrow waters, a direct-acting steam reversing engine is provided, the cylinder of which is attached to the back of the main cylinders, and controlled by levers from the starting platform. The gear for regulating the main stop valves is placed close to the reversing levers, and is of a dual nature. To permit of the accurate adjustment of the valves a screw gear worked by a hand wheel is provided, but in case of emergency the steam supply can be instantly shut off the engines by simply pulling a lever. At the after end of the engine room is the thrust recess, which extends from side to side of the vessel; in it the thrust blocks are secured to steel seats built upon the ballast-tank top. The thrust of each propeller is taken up by collars on the thrust-shaft bearing upon ten horse-shoe rings having large white metal bearing surface provided with water circulation. The tunnel shafting is made up in five convenient lengths, each carried on a pillow block, with white metal lining and water circulation in each. The propeller shaft is carried inside the skin of the ship right up to the stern frame and has on this account to be of extra length. To avoid corrosion where it is exposed to the salt water it is covered by a gun-metal liner from the fore end of the stern tube to the propeller boss. The propeller bosses are of cast iron, to which are secured by studs and nuts the bronze blades, four each, the propellers being 17 feet 10 1-2 inches in diameter.

In the thrust recess are fitted four donkey engines and auxiliary condenser with drain tank; also a refrigerator on Hall's patent. The donkeys are for salt-water service, fresh-water service, bilges, and one for circulating through the auxiliary condenser.

The electrical machinery is placed on the lower deck level on the forward side of the main condensers, either set being capable of lighting the whole ship, as well as driving a large number of powerful electric fans which are provided for ventilating purposes. The dynamos are driven direct by vertical Belle's compound steam engines, the steam and exhaust pipes of which are independent of all other machinery.

The pumping arrangements are on a very complete scale, and comprise principally two extra large duplex ballast pumps, one on either side of the engine room. The ballast and bilge-pipe connections are in duplicate, a complete system being on either side of the vessel, with connecting pipes at the after end of engine room; the two pumps may work independently, or both may be connected to draw from any one compartment of the vessel. By this arrangement it will be seen that in the event of a considerable leak occurring in any part of the ship there is ample provision for overcoming it.

Steam is supplied by four large double-ended boilers and four single-ended boilers. These boilers are on the natural draft system, and are arranged in two sets with a funnel to each set. The funnels are 115 feet high, and have an outer casing throughout their entire length whereby the hot air accumulating over the boilers may be drawn off. There are in all 48 furnaces, giving a large heating and fire-grate area. The main steam pipes are led in duplicate, each engine having a separate pipe the whole length of the boiler space; a valve is fitted on the after side of the forward engine-room bulkhead connecting these pipes for the purpose of equalizing the steam pressure at the engines.

The placing of the boilers in pairs permits the use of side bunkers throughout the entire boiler space, these bunkers being of sufficient capacity to carry the vessel across the Atlantic, and it will be observed that by this arrangement the coal runs naturally to the place at which it is required, thereby practically doing away with the necessity of carrying coal trimmers. A cross bunker is placed between the two sets of boilers.

For dealing with the large cargo which the vessel is designed to carry, ten powerful steam winches of the builders' own special make are placed on deck, with cylinders of 7 inches in diameter and 12 inches stroke, and provided with winding barrels of extra large diameter, thereby giving extra speed in hoisting cargo.

In addition to the large fresh-water tanks and for cases of emergency a large distilling plant for condensing salt water is provided. The steam steering gear is fitted in a special house on the poop and is worked from the bridge by a controlling shaft. It is of the Caldwell & Company's make, and is of ample power. The hand steering gear is arranged in the same house, and also Cumming's patent oil-cylinder rudder-brake, supplied by the builders.

When on her trials on the Clyde, the *Caledonia* attained a speed of 18 1-4 knots loaded, which is considerably in excess of what was required, and though this speed was attained within six hours of the time the engines were first started, everything worked with the most satisfactory smoothness. The indicated horsepower was 11,750. The *Caledonia* left Glasgow for New York on her maiden voyage on March 25.

New Armored Cruisers.

BY EDWIN CERIO.

The keel of the armored cruiser *A* was laid in November last at the Royal Navy Yard of Castellamare, Italy, the two new cruisers *A* and *B*, as they are referred to in the 1904 estimates, having been designed by one of the most able naval architects of the Italian navy, General Masdea. They embody a fortunate compromise between the requirements to be met by ships of their class, and mark in many respects a new departure in the armament and protection of armored cruisers. Though about identical in size to the United States cruisers *Charleston, Milwaukee,* and *St. Louis,* the Italian vessels differ from these in their military qualities, as they possess to a very high degree the tactical virtues of cruising ships: protection, armament, and speed. Some information on the new Italian cruisers will surely be of interest, as an opportunity is offered of comparing, in ships of the same displacement and dimensions, a very different distribution of fighting elements.

The principal characteristics of the armored cruisers *A* and *B*, *Charleston* and class, and of the new French cruiser *Edgard Quinet,* are gathered in the table given herewith. The construction of the *Quinet* was begun in Brest, France, at the end of September, 1904, so that she may be assumed to represent the up-to-date French naval policy and practice in the construction of swift armored cruising vessels. The three types of ships chosen will enable a comparison between the military qualities of fighting units intended to solve the armored cruiser problem, each from a different viewpoint.

Much blame has been given the naval authorities responsible for the *Edgard Quinet's* design, and for that of her sister ship *C* (French Navy Estimates, 1905). The *Quinet* is a typical specimen of those ships which have so well deserved their name of "coal-eaters." To obtain one or two knots in addition to the high speeds already obtained by cruisers above 10,000 tons displacement means to overpower these vessels, a practice which has proved most uneconomical, and which has led to failures such as the *Jeanne d'Arc* and the ships of the *Gambetta* class.

With a moderate displacement and a speed quite sufficient for cruising purposes the Italian cruisers carry a formidable armament. Though the number of guns is inferior to that of the *Charleston* and the *Quinet,* the calibers chosen are almost equal to those of the heavy guns of a battleship. Considering the ranges of modern warfare, the armament of *A* and *B* seems more appropriate to armored cruisers than that of the new French and American vessels of this class.

High speeds in swift cruisers must be made, up to a certain degree, paramount to other fighting qualities, and a vessel of 14,000 tons displacement running at 24 knots is certainly an ideal armored cruiser. But the unromantic side of the question must also be considered. The estimated cost of the *Quinet* is $8,000,000; that of the Italian cruisers $4,400,000. Making an allowance for the

Principal Characteristics.	New Armored Cruisers.		
	Italian. A and B.	United States. Charleston.	French. Edgard Quinet.
Displacement ... .tons.	9,6-5	9,700	14,000
Length on the water-line..feet.	427	423	528.2
Extreme breadth.......... "	68.8	65.5	70.5
Draft...................... "	23.5	23.25	26.5
Block coefficient...........	0.487	0.543	0.492
Approximate area of lateral plane (torpedo target) sq. ft.	9,700	9,500	13,500
Speed (estimated).......knots.	22.5	22.	24.
I. H. P. (designed)............	18,000	21,000	40,000
Admiralty coefficient......	287	231	201
Armor................	Terni.	Krupp.	Krupp.
Belt, maximum thickness, ins.	7⅞	4	6
Battery, " " "	7⅛	4	6
Casemates " " "	....	4	....
Barbettes of primary guns, "	?	None.	6
" " secondary " "	?	None.	6
Conning tower.............. "	7⅞	5	....
Armament:			
Primary......................	4 10-inch in double turrets, forward and aft, 8 8-inch in double turrets.	14 6-inch behind shields and in box batteries.	2 9.4-inch in single turrets, 14 6.4-inch in double turrets and casemates.
Secondary	16 3-inch.......	18 3-inch unprotected.	....
Tertiary........	8 3 pounders..	12 3-pounders, 12 1-pounders, 2 gatlings 8 Colts.	8 6-pounders, 16 3-pounders, 2 1-pounders.
Torpedo tubes { above water.	Two, at sides.	....	Three.
Torpedo tubes { submerged..	One, astern.	Four.	Two.
Coal supply { normal....tons.	700	650	1.500
Coal supply { maximum, "	1,500	1,500	2,400

difference of wages in France and Italy, it may be roughly assumed that the cost of two *Quinet's* would cover that of three *A*-type cruisers. On the other hand, three *A*-vessels would mean, strategically and tactically, a force far superior to two *Quinets*. Within probable ranges—4,000 to 8,000 yards—the armor carried by *A* defies penetration from the guns of the *Quinet* and *Charleston*, while the *A's* 10-inch guns would pierce both the *Quinet's* and the *Charleston's* side armor.

The comparison made above is founded on data given in the table, most of which is taken from official sources; when more particulars are known of the Italian cruisers now in course of construction, it will be most instructive to see how the weights of the different elements have been distributed, in order to obtain such a happy compromise as that which the two vessels seem to embody.

PERSONAL.

Captain C. O. Tilton, of Martha's Vineyard, Mass., has just been appointed captain of the steamship *Massachusetts* of the Atlantic Transport Line.

Mr. Charles S. Davis, for the past six years master electrician of the Bureau of Construction and Repair, Charlestown navy yard, joined, on June 1, the engineering staff of the Holtzer-Cabot Electric Company, Boston, Mass.

The Warren Steam Pump Company, of Warren, Mass., has opened an office in New York at 95 Liberty street, and Mr. W. D. Kearfoot, who has been well-known for many years in connection with the pump business, has been made manager.

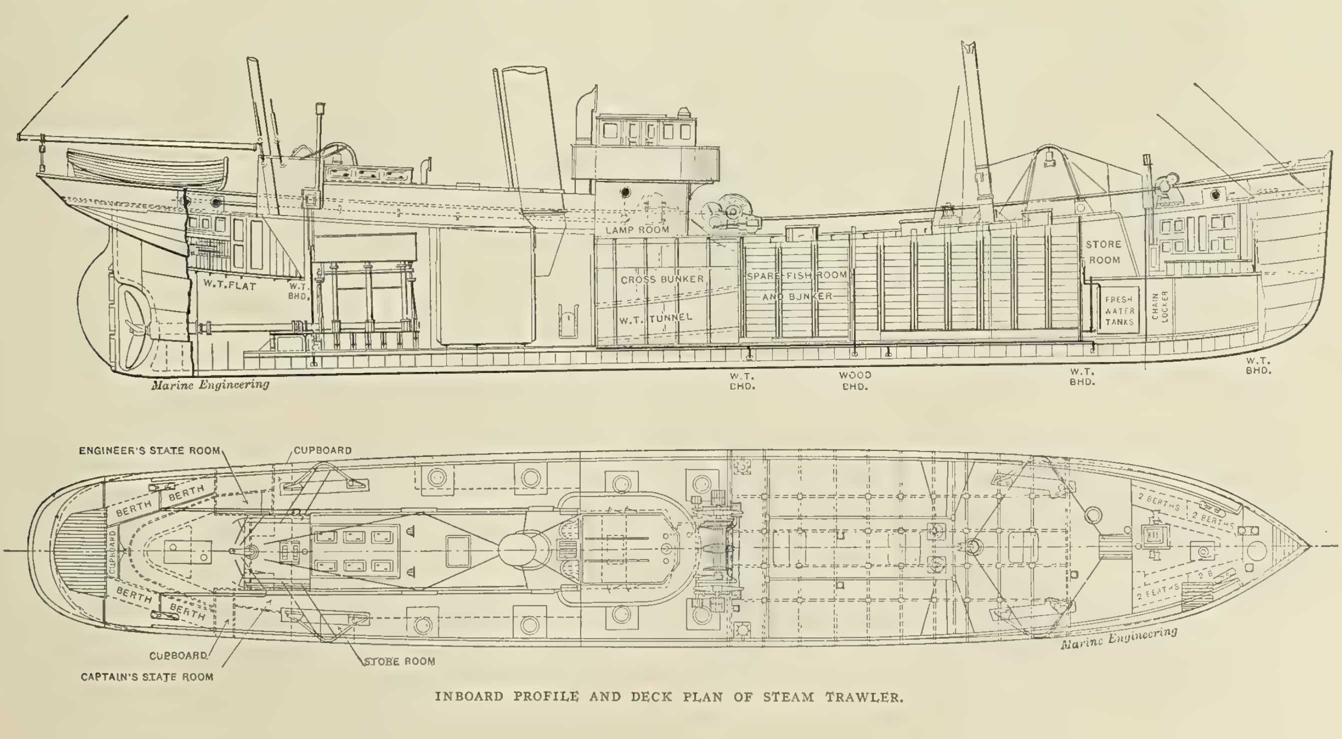
Mr. Eads Johnson has resigned his position as Superintendent of Construction of the United States Lighthouse Service, at Tompkinsville, N. Y., to become the Maritime Exchange representative for James Shewan & Sons, shipwrights and machinists.

The firm of Gardner & Cox, naval architects, has been dissolved, and Mr. William Gardner, retaining the old offices at 1 Broadway, will continue the business of a naval architect; while the Messrs. Cox have formed a new firm of naval architects and marine engineers, in copartnership with Col. E. A. Stevens and Mr. E. A. Stevens, Jr., under the firm name of Cox & Stevens, being located in the Morris Building, New York.

Developing the Canadian Merchant Marine.—Canada is taking steps to develop her merchant marine. The dominion parliament has just voted a liberal appropriation for the five schools of navigation at Montreal, St. John, Victoria, Halifax, and Yarmouth. A general preliminary training in seamanship is given to a large number of young men, many of whom ship with a good start in the knowledge required on merchant vessels.

The North Sea Steam Trawler.

In amplification of the article on the steam trawler, published at page 66, in MARINE ENGINEERING of February, 1905, we present herewith reproduction of a drawing of one of these trawlers, showing the general arrangement of the machinery and other compartments, and in particular giving an idea as to the location and extent of the storage capacity for fish, which occupies about one-third the length of the vessel. It will be seen that the entire design is very compact, the engine being placed very near the stern, thus minimizing the necessary length of shaft and the space required for its installation.



INBOARD PROFILE AND DECK PLAN OF STEAM TRAWLER.

Marine Engineering

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

The edition of the July issue of Marine Engineering comprises 5,500 *copies. We have no free list, accept no return copies and issue only enough to supply the regular demand, so that the* 5,500 *copies represent legitimate circulation.*

Motor Boats.

As announced last month, we are starting this month the publication of a series of articles on "Motor Boats," by Professor Durand, the scope of which will be very broad, and will cover the entire subject from a number of points of view. It is probable that this series will be continued for eight or ten months in order that the ground may be covered so thoroughly as to make a complete treatise on the subject.

The Japanese Naval Victory.

With the complete annihilation of the Russian Baltic Sea fleet and the practical sweeping of the Russian navy from Asiatic waters, Admiral Togo has won a naval victory which has been almost unparalleled in history. That this tremendous result should have been achieved in the face of an enemy almost equal in strength to his own fleet, and without the loss of a single ship of any importance, is certainly very remarkable. It brings to mind, especially to American thinkers, the two great naval victories which marked the course of our late successful war with Spain, and deprived the last-mentioned power of all of her American and Asiatic colonies. Admiral Togo appears to have lost several hundred men from his fleet, which is in startling contra-distinction to the American loss in Manila Bay and at Santiago, which numbered respectively eight men wounded in the one case, and one man killed and two wounded in the other. But it may be said in this connection that the disparity in force between the two fleets in combat was much less than was the case at Santiago, and probably than was the case in Manila Bay.

It had been generally expected that Admiral Togo would either have allowed the Russian fleet to reach Vladivostok and there be cooped up, much as was the other Russian fleet at Port Arthur; or that he would have endeavored, by a series of night torpedo attacks, or some other distracting method, to scatter portions of the Russian fleet, or perhaps cut off certain detachments, which could then be overpowered in detail, in accordance with the time-honored policy adopted on land by Napoleon. That he adopted neither of these policies has been the cause of considerable surprise, inasmuch as any ill-fortune attending his ships in such a battle as was waged might have resulted very disastrously, not only to the future conduct of the present war, but also to the entire future history of the Japanese Empire, and of the section of the Asiatic mainland immediately contiguous to the theatre of hostilities. He seems, however, to be a complete master of the difficult game of strategy, this mastery involving necessarily an intimate knowledge, not only of the potentialities and the limitations of his own force, but in an equal degree those of the enemy as well.

His success seems to have been the result of much the same elements as contributed to the success of the American navy seven years ago this summer. These elements may be briefly outlined as consisting in thorough discipline, a lively appreciation of the necessities of the case among both officers and men, a spirit of friendly rivalry among the various ships as to the efficiency in which they could be maintained, and the results which could be accomplished against the enemy, and above all to the admirable gunnery exhibited in all cases, the sort of attribute which gave rise seven years ago to the memorable expression "the man behind the gun." In distinct contrast with this situation, we have seen the Russian fleet go into a panic when encountering a fleet of fishing craft at night. We have seen them lie inactive for months, awaiting reinforcements and provisions; and though this latter period was generally supposed to have been occupied to a considerable extent in gunnery practice and in preparations generally for the mortal combat which it was recognized they would have to wage at the conclusion of their long journey, these preparations do not appear to have borne fruit in results, for the gunnery is reported to have been decidedly wild, nearly all of the shot having passed completely over the Japanese vessels at which they were aimed, in many cases striking ships far in the lee of the battle line, and doing considerable damage at points very remote from the immediate object of attack. This peculiar inability to keep the shot down to the hulls of the enemy's ships was a prominent characteristic of the fire of the Spanish ships at both of the naval battles above mentioned. It was also characteristic of the fire of the English ships in nearly all the naval duels of the war of 1812, and it is to this wildness that we can attribute in large measure many of the American victories of that conflict; while the Americans had been trained to bring their guns to bear in such a way as to hit the hull of the enemy, the British appear to have done their utmost to damage the sailing power; and the inevitable result of heavy loss in the personnel of the British crews and light loss among the American crews has been repeated at this distance of nearly a century in the only two wars which have given an opportunity for the testing of modern war appliances of the heaviest type. Thus we have once more an exemplification of the truism of the old adage—"History repeats itself."

At the present writing, the eyes of the whole world are centered upon the Russian and Japanese governments in earnest expectation of a deliberate move toward peace. The destruction of the Russian armada having made it impossible for the Russian government to maintain war except by relying solely for communication upon the Transiberian railway, and by confining the sphere of activities to northern Manchuria and the immediate neighborhood of Vladivostok, it has seemed to outside observers that with the continual record of ill-success met by the Russian armies in their campaigns against Nogi and Oyama nothing could be gained by a further prolongation of hostilities; and that, onerous though the Japanese terms will doubtless prove to be, they will be less difficult to meet than would be the case at the conclusion of another victorious campaign. The Japanese appear to be perfectly willing to make peace on reasonable terms, although some sentiment in that country seems to be in favor of pushing to the utmost the advantage they now have, before ceasing operations. It is to be hoped, however, that they will be content with the marvelous success which they have thus far achieved, and will be sufficiently lenient in their demands to present claims which the Russians can accept, and thus end a conflict which has lasted already about seventeen months, has cost an immense number of lives and tremendous resources of a financial character, and has solved the problems and cleared the issues for the solution and determination of which it was undertaken.

The Yacht Race.

Our congratulations are due to the designer, the owner and the skipper of the victorious *Atlantic*, winner of the Kaiser's cup. The magnitude of the victory makes it all the more gratifying to Americans that an American yacht, designed, built and owned by Americans, and sailed by an American citizen, should have so signally proven her superiority over all rivals. It recalls the memorable days of the old *America*, of more than a full half century past, and shows that, despite the influences which have resulted in all but sweeping the American flag from the high seas, we have not yet entirely lost the "sea habit."

Some More Appreciation of the Situation.

At the tenth annual convention of the National Association of Manufacturers, which was held at Atlanta, Ga., about the middle of May, the following resolution was unanimously adopted:

"Whereas, This Association has annually, for several years, pleaded for the restoration of a merchant marine, now imperative and indispensable for our present and future commerce, our exports having reached a total of nearly a billion and a half, and our imports over a billion, and still increasing; and

"Whereas, Our flag has almost entirely disappeared from the high seas, ninety-two percent of our entire foreign commerce having been transported in foreign-built vessels in 1903, and over ninety-five percent in 1904, including naturalized steamships under American registration; and

"Whereas, At the fifty-eighth Congress a Committee was created for the purpose of investigation and reporting upon the merchant marine necessities of the United States; therefore, be it

"Resolved, That the National Association of Manufacturers commends the work of the Merchant Marine Committee, heartily approves the passage of a bill for the upbuilding of American shipping in the foreign trade—for our passengers, mails, and war service, and requests Congress promptly to take action on such a bill, thereby making possible an American maritime power for the present and future expansion of our great commerce and as an auxiliary to our Navy."

At a dinner of the Business Science Club, held June 13, Mr. Ralph W. Grout voiced the sentiments of a large number of thinking Americans when he said:

"Do not compel us to use ships subsidized by foreign countries and sailing under foreign flags in the building up of our foreign trade. Give us American ships owned and sailed by Americans; fostered, protected and subsidized by the Government, under such conditions that our manufacturers and merchants may embark in the enterprise. While we are on this subject we will do well to remember the words of our President, that a first class navy is a very good thing to have handy for the protection of our rights upon the high seas and in the command of courtesy and respect where necessary, to say nothing of the protection it might be to our shipping and merchant marine, when the time comes that we have one."

We heartily concur in these sentiments.

THE DESIGN OF MARINE MACHINERY.

BY W. F. DURAND.

PART V.—*Continued.*

A careful study of these various paths, all of which were taken from a model representing normal proportions, together with others representing the results of other modifications, will serve to establish the following abstract of tendencies in the various cases:

(1) For case (1) in general, the curves showing paths of P are elongated or pointed ovals passing through narrow figures of 8 and into broad, open ovals at the extreme positions of S in vertical range. For low positions of S the figure is an oval with point at the top or a figure of 8 with the cross near the top and the large lobe of the 8 below. As the center S moves up the cross point moves down and the 8 narrows, passing through a nearly symmetrical narrow figure, beyond which it again widens as the cross point approaches the lower end, and beyond which it opens out into a pointed or open oval with point or smaller end down. In the meantime, the figure also rotates as a whole in such direction as to carry the upper end away from the link.

For a shift in the position of R from the concave side across the line of the arc to the convex side the rotation of the figure is but slight, but the oval changes rather quickly from point down to point up, or in the general direction corresponding to a movement of the cross point upward.

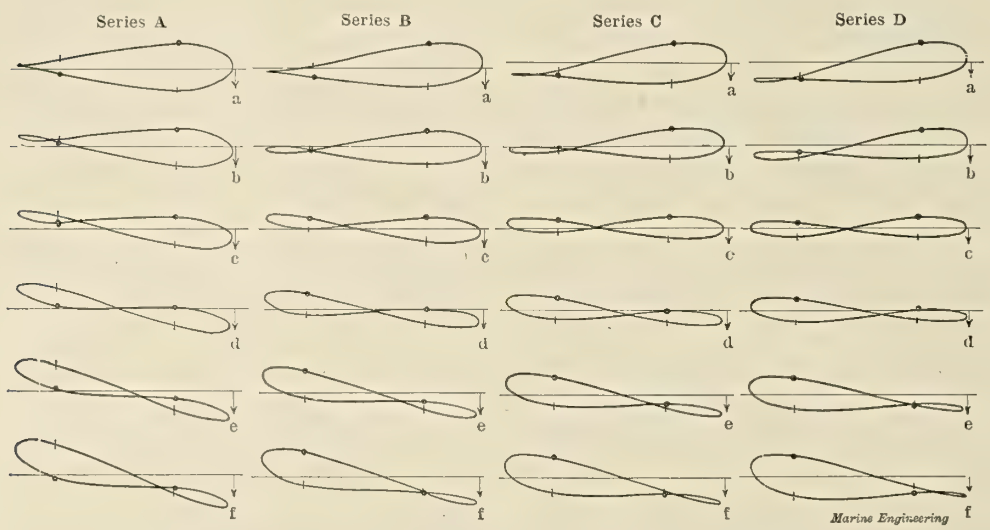


FIG. 32.—OVALS SHOWING PATHS OF GO-AHEAD END OF LINK, CASE (2). IN EACH CASE THE UPPER END OF THE PATH IS DENOTED BY THE SMALL ARROW, WHICH POINTS TOWARD THE BACKING END OF THE LINK.

For a change in the length of bridle rods the effects on the paths are usually slight. Very commonly the least width of figure, and hence the least possible block slip, will be given by the shortest practicable length of bridle rod, the points S and R being at the same time appropriately taken, the former in vertical rànge and the latter relative to the link arc center line.

For linked up positions of the gear the same general changes are met with, the figures themselves being gradually reduced in length and usually in amplitude, but with some tendency to rotation depending on the path of S relative to the vertical direction.

For a series of positions of the link covering the entire range from full gear ahead to full gear back, it is usually found that for the minimum amount of block slip the point S should follow a curved path, concave viewed from below, and hence opposite to that given by two usual locations of the rock-shaft above the level of the link, as in Fig. 29.

(2) For case (2) in general, the paths are figures of 8 passing into ovals at either extreme. For low positions of S the figure is an oval with point down. As S moves up the cross point appears and moves up also, while the figure rotates in such direction as to carry its upper end toward the link. For a shift in the location of R from the concave side of the arc across to the convex side, the figure rotates in somewhat pronounced manner in such direction as to carry the upper end of the figure away from the link, while the general character of the oval or cross point of the 8 changes more slowly, the latter moving upward.

For a change in the length of bridle rods the changes are but slight. As a rule the narrowest figure and best results as regards amount of block slip are obtained with the longest practicable length of bridle rod, the points S and R being at the same time appropriately taken, the former in vertical range and the latter relative to the link arc center line.

For linked up positions of the gear the same general changes are met with, and the same general remarks apply as for case (1).

(3) For case (3) the changes in the path of A with vertical change in S are readily followed without special discussion. For moderately linked up positions the paths are elongated ovals bent around in the same general sense as the arc followed by A. It is not customary in this case to vary the point of attachment relative to the link arc center line. The points R and A become in this case coincident.

Let us now turn to another point of the discussion and refer to Fig. 30. This shows that when the block is made fast in the link and one point of the latter is thus guided in the line of motion of the valve, the center of the link moves in a generally elongated oval or 8, bending around away from the go-ahead end of the link. Now, it will be clear that if the point R is taken at the center of the link and the bridle rods are carried out past the backing end as for case (1), then the center of the link will be guided in the arc of a circle convex to the go-ahead end, and therefore having its curvature in the same general direction as that of the oval h of the figure. On the other hand, if the bridle rods are carried out past the go-ahead end, as for case (2), then the center of the link will be guided in the arc of a circle concave toward the go-ahead end, and therefore having its curvature opposite to that of the oval h in the figure. It is readily seen that the path of the center of the link with the arrangement of case (1), as shown by the arc EF, will be a better approximation to the curved oval than with the arrangement of case (2), and we find here the reason for the narrower resultant figures and reduced block slip with the arrangement of case (1).

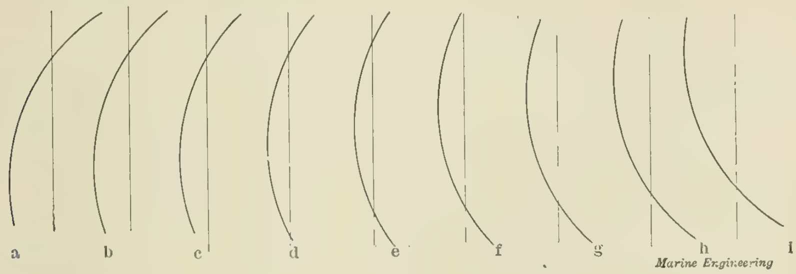


FIG. 33.

Let us now turn to another point of the discussion and examine the paths shown in Figs. 31, 32, with reference to the general standing of any given case with respect to the influence of block slip on the equalization of cut-off in the two ends of the cylinder, or the increase of lead at the bottom as compared with the top.

In each case the location of the point A at the opening of the valve is indicated by a dot and at closure by a small cross line. In Fig. 31, for case (1), the link lies to the left of the oval (above in the diagram) in any given instance, and it will be readily seen that for a tendency toward the equalization of the two points of cut-off the line joining the two corresponding marks on the oval should lie inclined toward the link at the top, while in order to give a relatively increased lead at the bottom the line joining the two points on the oval for steam opening should lie inclined away from the link at the top. It is readily seen whether or not these conditions are fulfilled, and to what degree.

Similarly in Fig. 32, for case (2), the link lies to the right of the path (below in the diagram), in any given instance, and it will be seen that for a tendency toward equalization of the two points of cut-off the line joining the two corresponding marks on the oval should be inclined toward the link at the top, while for a relative increase of lead at the bottom the line joining the two points on the oval for steam opening should lie inclined away from the link at the top. These conditions are thus seen in general to be the same for the arrangements of both cases (1) and (2), and are fulfilled or violated in varying degrees as indicated by the various paths in the two sets of series.

An examination of these various paths will show that the arrangement of Fig. 31 will give a reduced block slip with corrections for cut-off and lead in the right direction more readily and more effectively than the arrangement of Fig. 32, and this fact furnishes an added reason for the general preference which is given to the arrangement of case (1) as compared with case (2).

An application of these same general principles to the arrangement of case (3), the paths for which are shown in Fig. 33, will show that but one of the two conditions can be fulfilled with any one arrangement of the gear, and that if the center S is relatively low the cut-off correction will be in the right direction while the lead correction will be wrong. Similarly if the center S is high the lead correction will be in the right direction while the cut-off correction will be wrong.

It is furthermore seen that no matter what the arrangement of gear if the path of A is so nearly symmetrical that the lines joining the points corresponding to cut-off and steam opening are sensibly parallel to the line of valve motion, as in Fig. 32, series D, oval C, then of course there is no correction for either cut-off or lead due to the influence of block slip.

It is furthermore seen that so far as these corrections are concerned, precautions should be observed as follows:

For case (1) the point S should be low rather than high.

For case (2) the point S should be high rather than low.

For case (3) the point S should be low or high, according as correction for cut-off or lead may be considered the more important.

The discussion thus far has had sole reference to a valve gear with outside valve; or to the case in which the movement of the valve *above* mid position determines the flow of steam through the bottom port and the events for the up stroke, and vice versa *below* mid position for the upper port and down strokes. In the case of an inside valve the movement of the valve above mid position determines the flow of steam through the upper port and the events for the down stroke, and vice versa for the bottom port and up stroke. If the gear is still of the "open rod" configuration—that is, with the rods open when the eccentrics are turned *toward* the cylinder—then the various ovals for the working end of the link will be the same as for an outside valve, but with opposite relations to the ends of the stroke. Thus, in Figs. 31, 32, the ends of the ovals where the arrow is found will relate to the down stroke and the opposite ends to the up stroke. From these reversed relations it will result that the tendencies with respect to equalization of points of cut-off or to a difference in lead will be also reversed, and that for a tendency in the direction of more equal cut-off the line joining the corresponding two points on the oval should be inclined away from the link at the top and for a tendency toward a relative increase of lead on the bottom end the line joining the corresponding two points on the diagram should lie inclined toward the link at the top, as in series D, oval b. It is readily seen that in general these conditions are less readily fulfilled than for the outside valve, and hence, that the inside valve is at a slight disadvantage as compared with the outside valve in respect to this particular feature of valve-gear adjustment.

(To be continued.)

ABSTRACTS FROM RULES AND REGULATIONS OF THE AMERICAN BUREAU OF SHIPPING FOR OIL-TANK VESSELS ONLY.—Continued.

EDITION OF 1904.

ARRANGED BY HARRISON S. TAFT.

4. The horizontal stiffeners are to be of the plate, knee bracket (spaced not over two frame spaces apart) and face angle type as for athwartship bulkheads. They shall be worked in way of the horizontal stiffeners on athwartship bulkheads, to which they shall be bracketed. When the horizontal stiffeners on a longitudinal bulkhead are in the same tank as the vertical stiffeners on an athwartship bulkhead, said horizontal plate stiffeners are to have a double clip and bracket-plate connection to the athwartship bulkheads; with 5 rivets in each side of the brackets when the second number is under 19,000, but 7 rivets when the second number is or over 19,000.

5. Said longitudinal bulkheads are to have a single double-riveted angle bar, or double single-riveted angle bars on top to form the connection to the "crown deck" or to the top of the expansion tank. The flanges of said bars are to equal the bulkhead plating to which they are attached.

6. When a hold is over 20 feet in length a web plate stiffener as above (17-A-4 b) is to be worked at the center of said space.

7. When the machinery is located amidships the longitudinal bulkhead aft of the machinery space is to be connected to the top of the shaft tunnel with double angle bars, double riveted to the bulkhead plate. Or it may form one side of said tunnel, in which case the horizontal floor-plate stringer at the center line must be wide enough to be secured to said bulkhead plating with an angle bar double riveted in both flanges.

8. (*a*) The ends of a longitudinal bulkhead should extend through the cofferdams and thence taper for four frame spaces to the top of floors. The edge of the tapering part is to have double angle bars equal to the reverse

bars of an ordinary ship. Vertical stiffeners of similar scantling are to be spaced one frame space apart on each side.

(*b*) When the machinery is fitted amidships the forward end of the aft longitudinal bulkhead should extend through the cofferdam, and be securely fastened to the bulkhead at the aft end of the engine room. A web plate stiffener one frame space wide at the deck, tapering thence to the width of the stiffener angle at the bottom, is to be worked on the forward side of said bulkhead in way of above the longitudinal bulkhead. Said web is to extend from the top of the tunnel to the "crown deck," and it shall be equal in weight to the lower part of the bulkhead plating. It shall have a double face angle of the same scantling as those on the diagonal edge of the longitudinal bulkhead at their ends.

9. When the machinery is fitted amidships, fore-and-aft bunker bulkheads should be worked throughout said machinery space in the wings; or the keelsons should be increased in number and strength, with girders at the main deck, to compensate for the loss of strength due to the discontinuance of the center-line bulkhead.

10. Laps of all bulkheads in the tanks and of the shaft tunnel plating should be caulked on both sides.

11. Sluice valves, doors, etc., will not be allowed below the "crown deck."

18. Shaft Tunnel.

1. The entrance to said tunnel is to be from the upper deck at each end of the tunnel.

2. Tunnels are to extend through the cofferdams at each end. They are to have angle-bar connections, double riveted in both flanges to the bulkheads at the ends of the tunnel. The tunnel plating is to equal the lower part of the bulkhead plating. The flanges of the above angles are to equal the tunnel plating.

3. Stiffeners, equal to the frames of ordinary vessels, are to be worked at every frame, with close spacing of rivets, so as to provide for caulking said stiffeners.

4. The tunnel floor is to be plated, having a single angle-bar connection double riveted in both flanges to the plating forming the side of the tunnel.

19. Shell Plating.

1. The shell plating is to be of the same scantling as for an ordinary vessel, except for a flat plate keel.

2. When the machinery is located aft, the midship scantling of all plating below the numerical deck is to be maintained aft to the stern post, including the upper deck sheer strake, and all plating below it in vessels built under the three-deck rule.

20. Inner Bottoms.

1. Inner bottoms may be worked in the machinery space for water-ballast purposes.

2. They should be of a type having solid floors on every frame connecting to the inner bottom plating; or with girders on top of floors.

3. The top bars on the center-line keelson are to be 10 percent heavier than for ordinary vessels.

4. When the "solid floor plate" type of construction is used, the number of keelsons (see 17-9) need not be increased, but the longitudinal girders must be connected to the inner bottom plating with double angle clips.

5. If the "girders on top of floors" type of construction is used, they are to be spaced as in ordinary vessels, but are to be heavier as specified. Unless connected to the intercostal floor keelsons, they are to have a continuous double angle bar on the lower edge connecting them to the reverse bars and clips on top of the floors. They are to have an extra-heavy single angle bar connection to the inner bottom plating. When the second number is 42,000 or over, a horizontal plate stringer is to be worked on top of floors under said girders, said stringer plate being of the said weight, but in breadth 1-2 the depth of the floor plates of ordinary vessels.

6. The frame brackets and web frames are to have double clips to the margin plate. The frame brackets are to equal the weight of the web frames. The gusset plates, etc., are to be the same as in ordinary vessels.

7. The inner bottom plating strakes in way of the regular keelsons should extend through the cofferdams with a taper, and have an angle-clip connection to the bulkhead at the end of said taper.

21. Expansion Tanks.

1. When said tanks are worked at the sides of the ship, the continuous gunwale bar of the "crown deck" outside of said tanks should have a welded knee at said tank and be worked continuous around said tank, so as to connect the same to the deck plating; with both flanges double riveted throughout. The plating of a side tank is to equal that of the middle plating of the bulkheads.

2. When said tanks are at the center line of the ship their plating is to equal that of the upper part of the bulkhead plating. Said plating shall have a double-riveted flange or a single-riveted angle bar, double riveted in both flanges, connection to the "crown-deck" plating, with a similar angle-bar connection to the upper deck.

3. The stiffeners are to be equal to the frames of ordinary vessels. They are to be spaced at each frame and be bracketed at the top and bottom to the deck beams, with a 4-rivet connection to both beams and stiffeners.

4. When the hatchways are located at the sides of the expansion tanks, the tank plating at the "crown deck" may be worked so as to form the coaming of said hatchway. In which case said plating at the hatchway is to equal the weight of the upper-deck stringer of ordinary vessels, extending from the lower side of the "crown-deck beams to one foot above said deck, being double riveted to the regular tank plating. The "crown-deck" plating for two frame spaces at the fore-and-aft ends of said hatchway and of one deck strake at the side of said hatchway are to be 5 pounds heavier than otherwise.

5. When the hatchways of the upper deck, which are at the sides of the expansion tank, are 8 feet or more in length, they should be constructed as above, with the coaming plate extending below the upper deck beams so as to allow of a double-riveted lap to the trunk plating.

When the length is under 8 feet, the trunk plating may form a combined fore-and-aft and hatch coaming.

A metal oil-tight hatch cover should be fitted to each hold on top of the expansion trunk. Means should be provided for readily ascertaining the depth of oil in any hold.

22. Ventilation, etc.

Means must be provided for a thorough ventilation of all oil tanks, cofferdams, shaft tunnels, double bottoms, machinery space, coal bunkers, and all other compartments. Electric lights only will be allowed in oil vessels.

23. Butt Straps.

1. The butt straps of the flat plate keel; web frames; and side stringers are to be worked double. They shall be at least 5-8 of the thickness of the plates they connect.

2. The butt straps of the center-line keelson and of all deck stringers are to be worked double. They shall be at least 3-4 of the thickness of the plates they connect.

3. The butt straps of the middle-line horizontal floor stringers are to be worked single. They shall be at least 3 pounds heavier than the plates they connect.

4. Triple-riveted butt straps of the "crown-deck" plating are to be worked single. They shall be at least 5 pounds heavier than the plates they connect.

5. Butt straps of the shell plating are to be worked double. The outside ones are to be at least 5-8: the inside ones at least 3-4 of the thickness of the plates they connect.

6. Bosom pieces are to be of the same flange thickness as the angles they connect.

24. Riveting.

1. Rivets of less than 3-4 inch in diameter are not to be used in any part of the ship subject to an oil or other liquid pressure; except in expansion trunks, where 5-8 rivets may be used if the trunk plating is less than 14 pounds. The deep frame connections to the frames are to have at least 3-4 rivets spaced 6 diameters apart.

2. Pan or plug-neck rivets are to be used in all work subject to oil pressure. In tank bulkheads where the pressure comes on both sides, counter-sunk points as well as counter-sunk heads are to be used. All rivets in bracket plates, butts, and angles of side stringers, and web frames are to be finished peen fashion.

3. The Following to be Single Riveted:

(*a*) Laps or seams of the expansion tank plating.

(*b*) Laps or seams of the tank bulkhead plating when the depth to top of the "crown deck" from top of floors is under 13 1-2 feet; or the second number is under 19,000.

4. The Following to be Double Riveted:

(*a*) Laps or seams of the shell plating.

(*b*) Laps or seams of the shaft tunnel plating.

(*c*) Laps or seams of the "crown-deck" plating.

(*d*) Laps or seams of all bulkhead plating to the floors and to the center-line keelson in all cases.

(*e*) Laps of the expansion-tank plating when flanged to the "crown deck."

(*f*) Laps or seams of all tank bulkhead plating when the depth from top of floors to top of the "crown deck" is 13 1-2 feet or over; or the second number is 19,000 or over.

(*g*) Laps and butts of the inner bottom plating; except the center-line strakes.

(*h*) Butts of the "crown-deck" plating when the second number is under 72,000.

(*i*) Butts of the expansion-tank plating.

(*j*) Bulkhead frames in both flanges.

(*k*) Gunwale bars of the "crown deck."

(*l*) Bounding angles to the expansion tanks.

5. The Following to be Triple Riveted:

(*a*) Butts of the flat plate keel.

(*b*) Butts of the center-line keelson.

(*c*) Butts of the web frames.

(*d*) Butts of the side stringers.

(*e*) Butts of the horizontal floor stringer at the center line throughout.

(*f*) Butts of all the deck stringers.

(*g*) Butts of all the shell plating. They are to have three full rows of rivets.

(*h*) Butts of all the "crown-deck" plating when the second number is 72,000 or over.

(*i*) Butts of all center-line strake of the inner bottom plating.

6. Double Zigzag Riveting to be Used as Follows:

(*a*) Both flanges of a transverse tank bulkhead frame bar and bounding angle.

(*b*) Both flanges of the "crown-deck" gunwale bar.

(*c*) Bulkhead stiffeners which are to be caulked.

(*d*) Water-tight staple work at the keelson and side-stringer junction with all bulkheads.

(*e*) Both flanges of the expansion tank corner bars.

(*f*) Both flanges of a single bar connection of a transverse to a longitudinal bulkhead.

(*g*) Both flanges of the coaming bars to the expansion tank and deck plating.

7. Bosom Pieces.

(*a*) Those to the center-line keelson and side-stringer angle bars are to have three rivets on each side of the butt.

(*b*) Those to the reverse bars, 4 rivets on each side of the butt.

(*c*) Those to the deck gunwale bars, 3 rivets on each side of the butt.

8. All frames are to have at least a 3-rivet connection to a flat plate keel.

9. Reverse clips on the floors or frames at all keelsons, stanchions, and side-stringer angles are to have at least a 4-rivet connection to the floors or the frames.

10. Reverse clips on the web frames at the diamond plate connection to the side stringers are to have at least 3 rivets in each of the clips to the web frame.

11. Distance between rows of double or zigzag riveting is to be the same as for ordinary vessels.

12. All rivets in the bulkhead bounding bars; bulkhead shell liners; and all bounding bars in the oil-tank spaces should be caulked.

25. Spacing of Rivets.

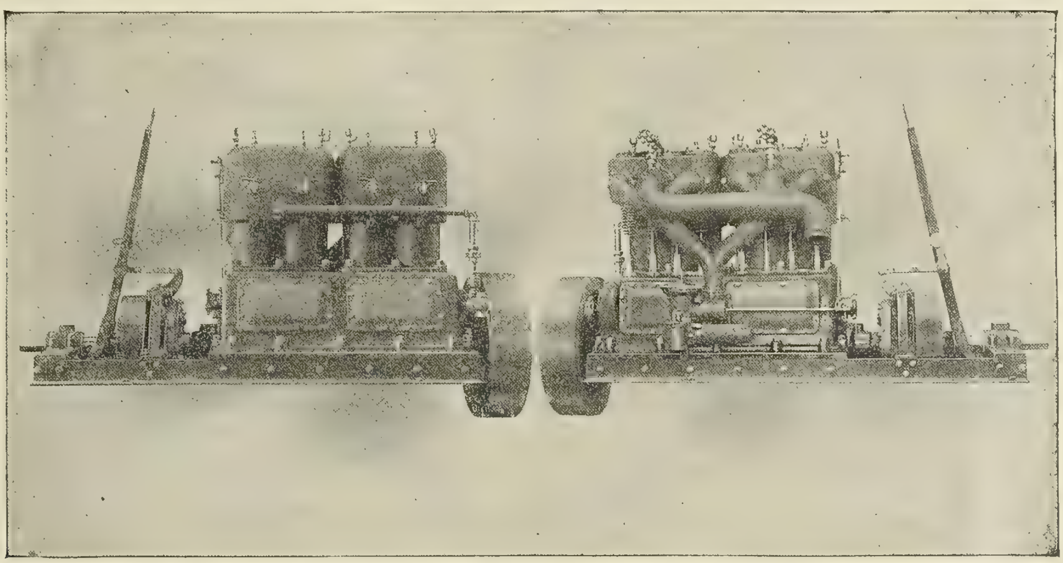
		DIAS.
1. Double chain riveting		3¼
2. Double zigzag riveting for oil-tight work (each row)		4
3. Single riveting of laps or angles for oil-tight work		3
4. All bracket plates; knees; non-watertight clips; clips not connected to the shell plating,	Single riveting	4
	Double and zigzagged.	5
5. Middle-line keelson angle bars; clip connecting side stringers and keelsons to the shell plating,	Single riveting	3¾
	Double and zigzagged.	4¼
6. Ordinary frames to shell plating; reverse bars to floors; web frames and frames; deck plating to beams; bulkhead and expansion-tank stiffeners not caulked; keelson and stringer running angles not caulked; web plates to frames; deep frames to frames,	Single riveting	6
	Double and zigzagged.	7½

NOTE.—For Riveting Table see Table 18, on page 221.

ENGINEERING SPECIALTIES.

A New Type of Two-Cycle Engine.

The engine which we illustrate on this page has been placed upon the market by the Racine Boat Manufacturing Company, of Muskegon, Mich., and is controlled by one lever which simultaneously handles the reversible propeller wheel, the spark commutator, and the throttle on the carbureter. By this means a constant speed on the engine is maintained no matter what the load, so that when placed on a launch the speed of the boat may be varied to suit any requirements up to the maximum of which the engine is capable, going either ahead or astern. The carbureter is of a special type in which the usual noisy compensating valves and springs are omitted, and is the direct outcome of a large amount of experimentation. The engine is made with one, two, or four cylinders.



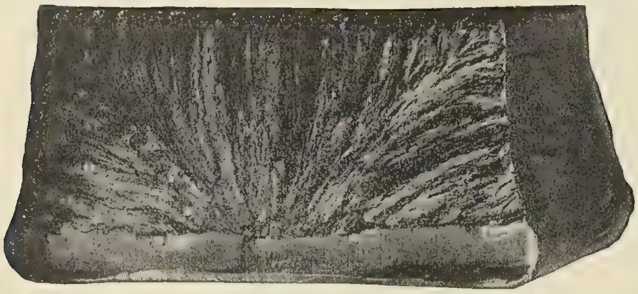
Cook's Metallic Packing.

One of the most trying difficulties before the successful operation of metallic packing on vertical engines has been the complete arresting of condensation. This, if it is not entirely controlled, is a very troublesome thing, with reference to wrist pins, journals, commutators, etc. In Cook's standard vertical double metallic piston-rod packing, made in Louisville, Ky., this has been accomplished by means of placing two sets of metallic packing together. The upper or main set serves to hold the steam pressure, while the lower set catches water and conveys it off through the threaded opening of the lower gland. If desired, a drain pipe can be screwed into this gland and led to any convenient place. This packing is also used in extra heavy duty service, though, in such instances, the drain pipe and opening in gland are omitted, thus working both sets of packing under pressure.

A New Bearing Metal.

Although there are on the market a number of metals for bearing purposes for which claims of superiority are made, the metal illustrated by the accompanying cut is said to possess more than usual features of interest. The manufacturers have given it the name of Fibro metal, the cognomen being derived from the fibrous quality which a fracture reveals in its structure. The composition is of a tin and aluminum base, and the fibre has the remarkable characteristic of radiating always from the chilling surface.

In the case of wood it is known that the end of the fibre is much stronger in resistance than the side, and that it will stand a greater amount of sliding friction as well as crushing weight. This was the principle for which the metallurgist who is responsible for this alloy worked, and his efforts were extended over a period of twenty years. A close examination of this metal shows it to be so fine in texture, with no granular matter intervening, that it might be called a truly chemical compound—not a combination of metals, but a new metal in itself. Ordinarily metals of this class will not admit of remelting and being used over again, owing to the grosser metals in the composition (those which melt at the lowest point) volatilizing and burning up before the finer metals begin to melt. This makes the alloy harder and harsher with each melting, and renders it quite useless. Fibro may be remelted as often as desired, and will retain all the

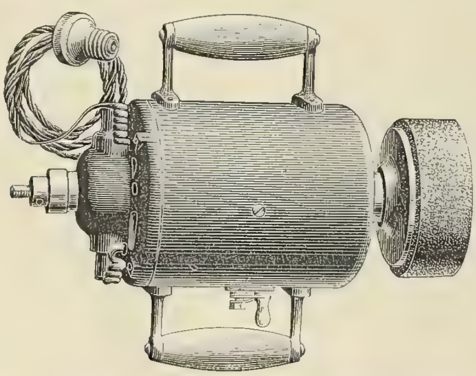


original qualities. Its toughness and malleability permits it to stand the severest shocks without becoming brittle. Under a steam-hammer test it has been pounded out to 1-3000 of an inch, and could be beaten much thinner by hand.

The Buda Foundry and Manufacturing Company, of Chicago, who are the manufacturers of this metal, are offering it as being particularly adapted for ships' bearings. Certain it is that this new alloy has features of interest, and the claims made for it are well worth investigating.

Portable Electrical Hand Grinder or Sander.

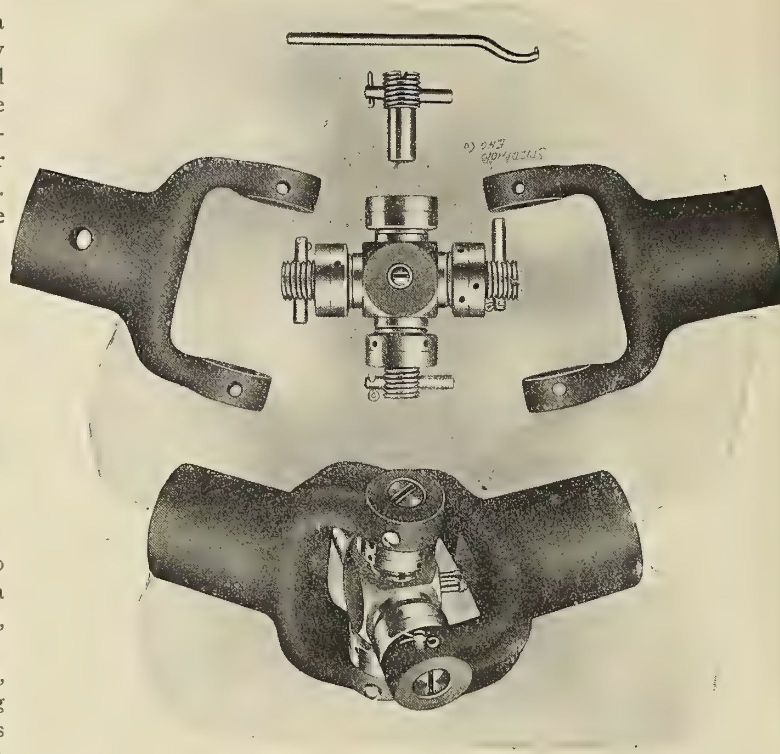
We here illustrate a new tool recently put on the market by the Hisey-Wolf Machine Company, Cincinnati, O. It is a handy little machine and adaptable for grinding, buffing, polishing, sanding, or other work of this nature, as any kind of wheel can be attached, according to the work to be done. The driving power is obtained from the ordinary incandescent lamp socket, direct current. This tool is light in weight and can be carried anywhere, as any length cord can be used.



The motor is enclosed and dust-proof, and the bearings are adjustable to wear. It is under the immediate control of the operator at all times by means of a switch at the handle. Two handles are located diametrically opposite, enabling the operator to hold it firmly and to manipulate it to advantage. The tool is made in two sizes of about 1-4 horsepower and 1-2 horsepower, weighing 14 and 22 pounds respectively. An adjustable extension spindle of about 5 inches is furnished if desired. The value of this tool can be readily recognized, and the builders send it subject to trial to all possible users.

An Adjustable Self-Oiling Universal Joint.

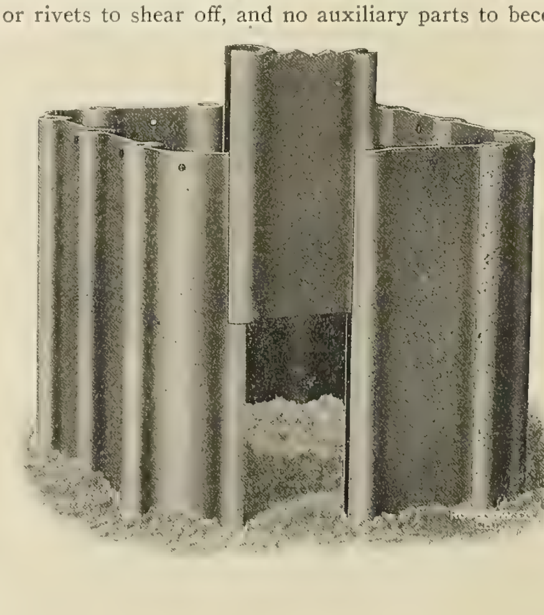
The universal joint, which we illustrate, is manufactured by the Baush Machine Tool Company, of Springfield, Mass., in sizes capable of transmitting from 5 to 50 horsepower. It is said to



be strong and durable, besides being very simple in construction. It is self-oiling and adjustable for wear. The forks are made of steel castings and the transmission spool or block of bronze, the latter being bored through from end to end of the projecting arms to receive the trunnion screw, leaving in the center an oil reservoir. The diameters of the joints vary from 1-4 inch to 4 inches, dependent upon the amount of power to be transmitted.

A New Steel Sheet Piling.

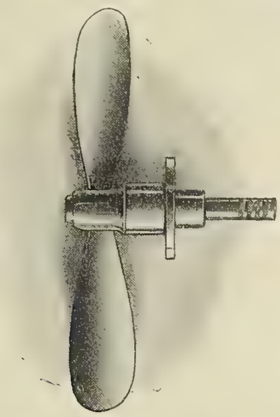
This piling is a plain rolled section, complete in itself, without bolts, rivets, or other attachments, and is ready for use as it comes from the mill, for all purposes for which sheet piling can be used. It is made absolutely watertight by packing the grooves with mud, clay, or any suitable material at hand, and is unequaled for dams, cofferdams, locks, or work where water-tightness is a necessity. The intersliding and interlocking features are perfect, and prevent the pulling apart edgewise or the turning laterally of the adjacent pile. The flat web and cylindrical ribs give great strength and offer the least resistance in driving or drawing. There are no bolts or rivets to shear off, and no auxiliary parts to become lost



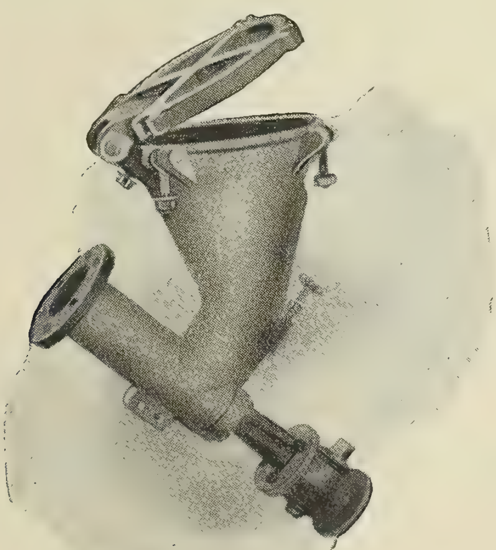
or damaged. The interlocking arrangement is self-contained; the alignment is perfect; the piling is balanced as to its center lines, and minimizes excavation. There are no angles or corners; the rounded ribs make it unsurpassed for wharves and docks. Each pile is complete in itself and is interchangeable. It is rolled in sections weighing 35 pounds and 40 pounds per foot, measuring 12 inches from center of large groove to center of small groove, and in lengths as required. The manufacturers are the United States Steel Piling Company, of Chicago.

The Spaulding Reversible Propeller.

Much of the trouble arising from the ordinary forms of reversible propellers is traceable to obstructions lodging in the sleeve tube which operates the reverse mechanism, and to the failure of the hub to withstand the wear and tear due to the collection of sand and other *debris* at this point. To overcome this objection



the Spaulding Gas Engine Works, of St. Joseph, Mich., employ a propeller which has a solid shaft to operate the reverse, thus eliminating completely the use of the sleeve tube and throwing the strain of the thrust upon the stern bearing, and ultimately upon the skeg of the boat, thereby relieving from all strain the engine and the engine bed. This device is said to be absolutely dirt and grit proof and to work very satisfactorily.



New Hydraulic Ash Ejector.

This ejector, which is placed on the market by the Marine Manufacturing and Supply Company, 157 South street, New York, is stated to be capable of ejecting a larger amount of ashes on a given consumption of water than any other similar instrument made. The auxiliary nozzle shown at the right of the illustration carries a stream of water down the side of the hopper, thus clearing the same and assisting the formation of the main jet vacuum by filling the discharge opening with water. With a water pressure of 125 pounds per square inch, this ejector will take care of ashes as fast as two men can shovel them into the hopper.

TECHNICAL PUBLICATION.

Mechanics of Air Machinery. By Dr. Julius Weisbach and Professor Gustav Herrmann. Translated by Amasa Trowbridge, Ph.B., Columbia University. Pages 206; figures 91; two folding plates. New York: D. Van Nostrand Company, 1905. Price $3.75 net.

The first part of this book takes up the movement of air in ventilation and goes into both natural and artificial methods of ventilation, with a considerable amount of material on the theory of the subject. The next section, which is by far the largest in the work, is devoted to blowing machines, and treats of vacuum pumps, tuyeres, and various problems connected with the design and operation of systems for hot-air blast and all sorts of purposes for which blowing engines are used. Another section treats of air compressors, while the last two are devoted respectively to rotary blowers and fans. The appendix, by the translator, covers about fifty pages, and is taken up with a discussion upon recent American practice in this field. The latter part of the work is profusely illustrated with both half-tones and line cuts, and is rather a review of the general field than any attempt to enter into the theory of the subject, such as is discussed in the original work in German. As is almost universal with works in the German language, the theory is very largely concerned with mathematical formulæ, involving both rational and empirical expressions concerned with the flow of air, and its control for useful purposes.

QUERIES AND ANSWERS.

All reasonable questions concerning marine engineering received from and signed by subscribers will be answered by the Editor in this column. All communications must bear the name and address of the writer.

Q. 294.—Please answer the following questions regarding good practice in the design of four-cycle marine gasoline engines:

(*a*) What is the proper mixture of gasoline and air?

(*b*) What is the heat of combustion?

(*c*) What is the specific heat of the products of combustion?

(*d*) What is a proper velocity to use in designing inlet and exhaust passages? C. R. S.

A.—(*a*) A very common mixture would be one volume of gasoline vapor to five of air.

(*b*) The heat of combustion is given as 600 B.T.U. per cubic foot of mixture. The temperature of combustion is estimated at 6,380 degrees Fahrenheit.

(*c*) The specific heat of the products of combustion are given as .206 at constant volume, and .28 at constant pressure.

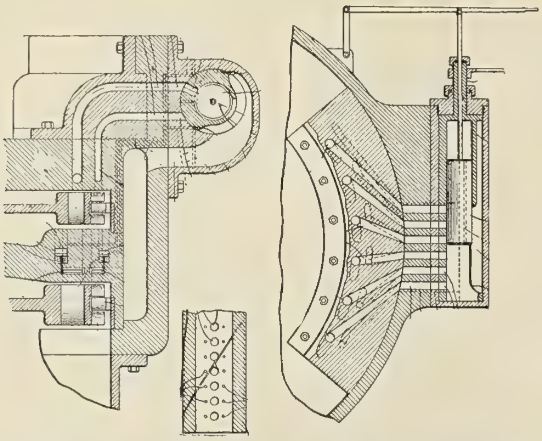
(*d*) The velocity usual in designing inlet passages is 60 feet per second where automatic valves are used, and 90 feet where the valves are operated by external mechanical means. For exhaust passages the velocity of discharge is usually figured at 75 feet per second.

The above information is taken from Hutton: *The Gas Engine.*

SELECTED MARINE PATENTS.

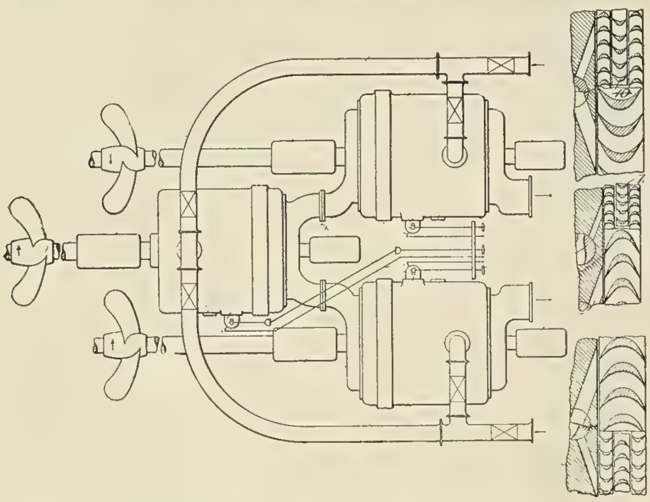
788,005. CONTROLLER MECHANISM FOR TURBINES. JAMES WILKINSON, BIRMINGHAM, ALA., ASSIGNOR TO WILKINSON TURBINE COMPANY, BIRMINGHAM, ALA.

Abstract.—One object of this invention is to simplify the means for controlling a reversing or two-speed turbine wherein independent nozzles or groups of nozzles operate with different driving effects upon one or more compound bucket-wheels. More specifically, it is an object of the invention to dispense with the plurality of supply-valves which in common practice are utilized to vary the flow of motor fluid through the several supply nozzle-passages and to substitute therefor a multiported controller-valve through which the motor-fluid supply for the whole turbine flows directly into the nozzle-supply passages, the valve being adjustable to determine the groups of nozzles to which pressure is to be supplied and the controller device acting to determine the volume of motor fluid admitted to the active working passages. Twenty-six claims.

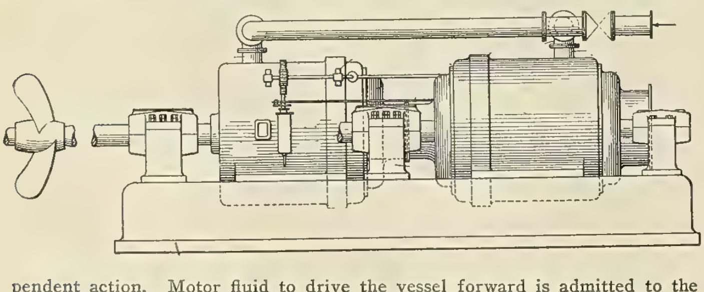


788,006. COMPOUND MARINE TURBINE. JAMES WILKINSON, BIRMINGHAM, ALA., ASSIGNOR TO WILKINSON TURBINE COMPANY, BIRMINGHAM, ALA.

Abstract.—The invention relates to improvements in a compound marine turbine the several turbine units of which are so constructed and coupled as to secure in a comparatively simple manner and without loss in the efficient action of the motor fluid the requisite variations in speed and power as well as independent control of the several propeller-shafts necessary for the successful propulsion and steering of vessels, and at the same time to adapt one or more of the turbine units to reversal with high torque.



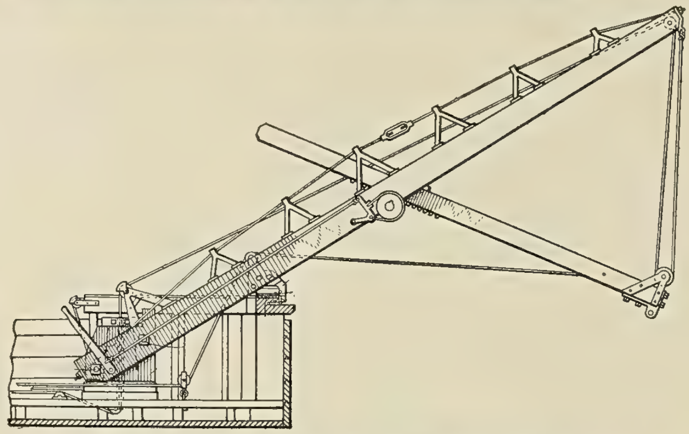
Patents have been issued for turbines provided with independent groups of working passages designed to drive the shaft at two speeds—one representing full and the other cruising speed—and adapted to reverse the vessel at half speed or drive it forward at cruising speed in addition to their normal operation in driving forward at full speed. It is the purpose of the present invention to combine these novel types of turbine to provide a multiple or compound marine turbine of high efficiency and wide range of usefulness which is compact in form and capable of being readily controlled. To this end there is provided a group of three two-speed turbines, each of which drives a separate propeller-shaft and is provided with an independent controller mechanism, so that they are capable of inde-



pendent action. Motor fluid to drive the vessel forward is admitted to the initial or high-pressure two-speed non-reversible turbine, to which the secondary two-speed reversible turbines are coupled by suitable conduits in what may be termed "multiple series"—*i. e.*, a separate conduit leads from the exhaust-head of the high-pressure turbine to the supply-head of each secondary turbine, from which the pressure has access to the full-speed forward-driving working passages of each of these latter turbines under the control of their respective controller mechanisms. When reversing the vessel, these secondary units become high-pressure turbines, the motor-fluid pressure being admitted directly to their high-torque reversing working passages, while their controller mechanisms close the forward-driving working passages. Thus being independent, one of these latter turbines may operate in series with the initial turbine while the other is reversing, or both may operate in multiple, driving the vessel forward, or both may reverse when the high-pressure turbine will be out of service, its only communication with the exhaust or condenser being through the full-speed working passages of the secondary turbines which are then maintained closed. For cruising motor fluid is admitted to the half-speed working passages of the initial turbine to drive its propeller-shaft slowly, and the fluid exhausting into one or both of the secondary turbines will be lower in pressure than when operating at full speed, so that the speed and power of these latter turbines will be reduced. This will effect a relatively slow speed of propulsion of the vessel without sacrificing any economy in operation. Twenty-four claims.

789,322. CRANE AND BLOCK FOR DREDGE-BOATS. GEO. W. GERHART AND JOS. B. GERHART, OF LAWRENCE CO., ILL.

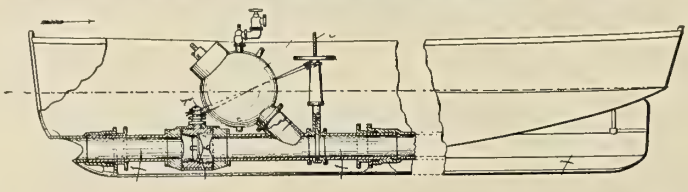
Claim.—2. In a crane for dredge-boats, the combination with the crane and pivoting means, of a segmental track for supporting said crane, said track being constructed so as to allow the crane to be lowered.



5. In a crane for dredge-boats, the combination with the crane, of a crane pivot-block to which said crane is secured and a crane-block pivot-pin constructed to receive said crane pivot-block and provided with a central opening through which the bucket-operating cable passes. Five claims.

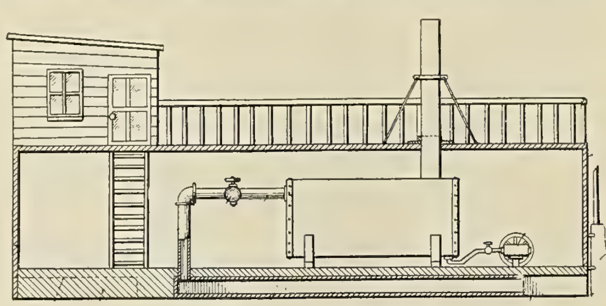
789,334. APPARATUS FOR PROPELLING SHIPS OR BOATS. FINGAL CECIL ORR, STILLORGAN, IRELAND.

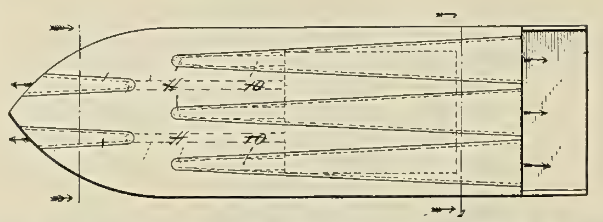
Abstract.—In this invention the ship or boat is propelled by the explosion at short intervals of time of gas or explosive vapor or petrol or other explosive material acting directly on the water through a pipe or pipes provided with non-return valves and opening out of the vessel ahead and astern below the water-line and arranged in such a manner that the expansion of the gases resulting from the explosion forces the water from the pipe or pipes at the stern or at the bows, according to which of the



non-return valves is open, which has the effect of propelling the vessel in the opposite direction to that in which the water is being expelled. The invention consists principally of improvements in the construction of the combustion-chamber and parts immediately connected therewith whereby the explosive charge in the combustion-chamber is maintained under any desired degree of compression until firing and then acts upon the water in the water-tube when the maximum explosive pressure has been reached, so that by this means the full benefit of the pressure due to the compression and explosion of the charge is obtained and after each explosion the pressure of the products of the previous combustion in the combustion-chamber falls to a low pressure, so as to insure economy in working. Six claims.

789,641. BOAT PROPELLING MECHANISM. JOHN A. WEEKS, TULSA, I. T., ASSIGNOR OF ONE-HALF TO LUTE L. LEWIS AND ROBERT H. PATRICK, TULSA, I. T.





Claim.—4. In a boat propelling mechanism a plurality of disconnected tapered ducts having their larger ends disposed, respectively, at the bow and stern of the boat, and means for supplying a fluid under pressure to the ducts. Four claims.

Marine Engineering

AUGUST, 1905.

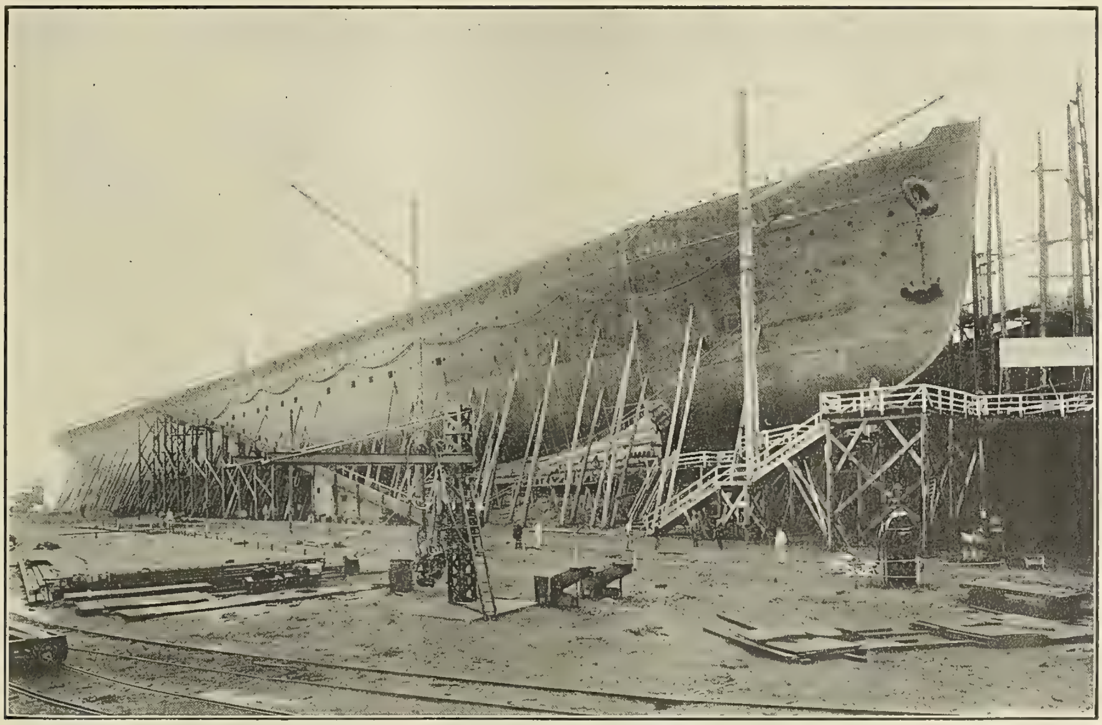
NEW PASSENGER STEAMER LA PROVENCE.

BY L. RAMAKERS.

On the 21st of March there was launched from the Peuhoët works at St. Nazaire, the passenger steamer *La Provence*,* destined for service between Havre and New York, which will be not only the fastest but at the same time the largest of all ships in the French mercantile marine. The length over all is 191 meters (627 feet); beam, 19.8 meters (65 feet); depth, amidships, 12.7 meters (41.7 feet); normal draft of water, 8.15 meters (26.75 feet); corresponding displacement, 19,190 metric tons (18,870 gross tons); coal capacity, 3,900 cubic meters (3,200 gross tons); horsepower, 30,000, actuating twin screws, with a speed of 23 knots. The number of passengers for which provision has been made is 397 of the first-class, 205 of the second-class, and 900 of the third-class, a total of 1,502.

The crew will be composed of 435 persons, which, with the full complement of passengers, will make a total of 1,937 persons who can be carried on this ship. The ship has been studied with a view of offering to the passengers not only the guarantee of absolute security but also of desirable comfort.

The general appearance is similar to that of the two last passenger steamers put in service by the Compagnie Générale Transatlantique, *La Savoie* and *La Lorraine*. The designers endeavored to realize in *La Provence* a greater speed than with the last two, and have been limited in the development of their ideas simply by the dimensions of the docks in the port of Havre. The construction of the ship has occupied a total of more than 1,800 workmen on the hull, engines, and boilers.



LA PROVENCE ON THE STOCKS.

The hull is constructed entirely of Siemens-Martin steel, of which metal more than 8,000 tons has been used. A double bottom extends the entire length, except for a short space forward and aft. This is divided into ten water-tight compartments forming water ballast of a total capacity of 1,800 cubic meters (1,770 gross tons). The ship is divided from bow to stern into twenty water-tight compartments by twenty-one transverse bulkheads. As a general principle, with an aim at security, these bulkheads below the second deck are not pierced by doors of any description, and such water-tight doors as were found indispensable have been made in each case capable of being closed by arms and mechanism of hydraulic machinery, which permits closing them separately, or all at once, from the navigating bridge, in about twenty seconds. Thanks to this installation the most complete security is assured. In case water enters any compartment, the installation of steam pumps is capable of discharging about 3,000 tons per hour.

*See Marine Engineering, May, 1905, page 206.

As a means of additional precaution for the saving of passengers in case of disaster, there are twenty lifeboats and six life rafts. The lifeboats are fitted with a special arrangement permitting their being launched by four men each within a space of 40 seconds.

The ship is divided in its height by six steel decks which are named from the bottom: the fourth, third, and second decks, main deck, promenade deck, and awning deck. The four last decks are covered with wood of a mean thickness of 60 millimeters (2.4 inches). Above the awning deck there are two deck houses, one at the forward end containing the apartments of the captain and officers, surmounted by a small chart and pilot house, the latter being situated at a height above the water of 15 meters (49 feet); the other deck house, at the rear of the awning deck, contains a café and also a wireless telegraph station. The lifeboats and life rafts are placed upon this deck. The promenade deck extends the entire length of the ship, but the central part for a length of about 120 meters (394 feet) is devoted solely to passengers of the first-class. The forward and aft ends are occupied by winches and apparatus for hoisting cargo.

This deck in the part devoted to passengers carries two deck houses, the forward one having a length of 110 meters (361 feet), and containing the principal entrance for first-class passengers, the music and social halls, as well as a series of state rooms and apartments de luxe. Some of the latter include a cabin with sofa, a bedroom, and a bath room. The after deck house contains the principal entrance of the second-class, and their cabin and smoking room. The main deck contains four classes of accommodations entirely distinct from each other, which are from the bow as follows: *First,* the accommodations for sailors and stewards, as well as several rooms for accessories, etc. The *second,* which has a length of 105 meters (345 feet), is devoted at the forward end to the first-class smoking room; in the central part between the two funnels is the first-class dining saloon, which is 20 meters (65.6 feet) long and 14 meters (46 feet) wide, and can accommodate 250 passengers at the table at one time. Forward of the dining saloon are the compartments of the doctor and purser, opening directly upon the main entrance, which places these two functionaries immediately in touch with the passengers. In this part of the ship in various locations are found the galleys, bakeries, and other offices of the ship, grouped in the neighborhood of the after funnel. In wake of the machinery compartments are the quarters of the stokers and oilers, while the rear end of this section is occupied by the accommodations of the engineers. *Third,* a compartment containing the dining saloon of the second-class, which is immediately below the space occupied by the smoking room and cabin of this class. *Fourth,* the poop, containing the steering gear and a series of chambers devoted to refrigerating machinery and outfit.

The first 'tween decks is almost entirely devoted to accommodations of the first and second classes, the central part being reserved to passengers of the first-class, who are thus guaranteed the best results from the effects of pitching. At the center is a dining hall for children, a hair-dressing establishment, and a ladies' cabin. The passengers of the second-class occupy a group of state rooms situated aft of the engines, while at the extreme forward and aft ends of the ship are the accommodations for passengers of the third-class and the crew. At the forward end of this deck are found also a hospital, infirmary, and pharmacy.

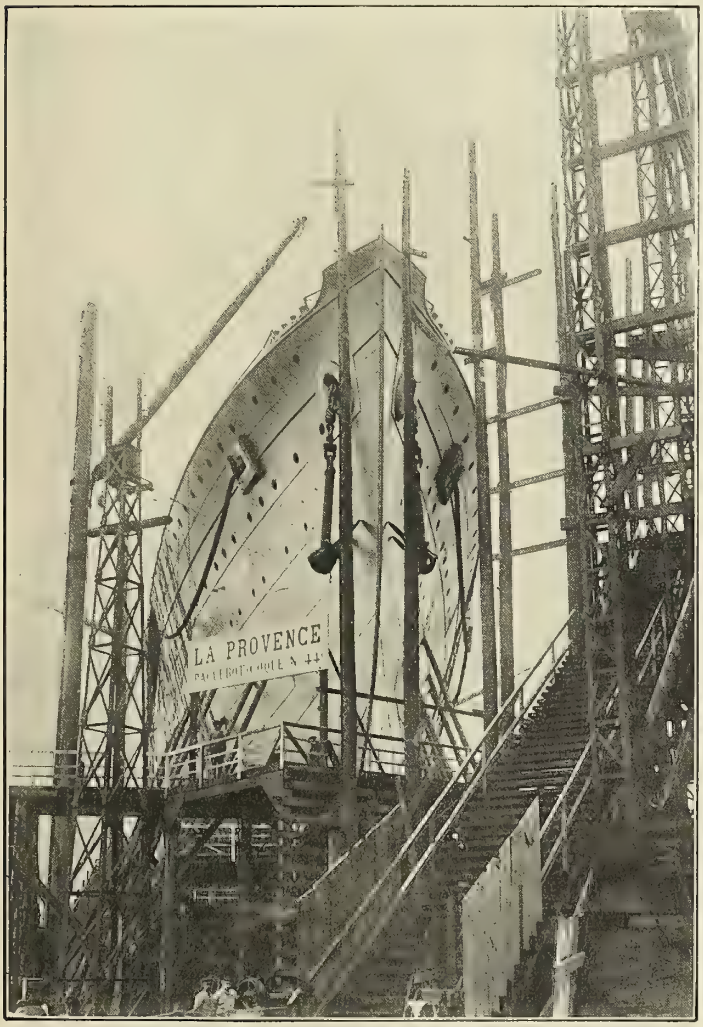
The second 'tween decks contains at the forward and after end quarters for the passengers of the third-class, as well as those for the stokers and coal passers, and in the central part the engines and boilers. The third 'tween decks is occupied by cargo spaces, as well as by a part of the bunker arrangements. This summary description of the arrangements of the ship shows that the passengers of various classes are quite separated from each other.

The arrangement of the parts of the ship reserved for passengers has been the object of especial care with regard to conditions of hygiene and ventilation. The decoration of the state rooms of the first- and second-classes is entirely in varnished mahogany. All of the first-class state rooms are furnished with electric lights, while certain state rooms, called "1-2 de luxe," as well as the apartments de luxe, have telephones, permitting the passengers to order without delay anything they may need. The decorations and drapings of the cabins, smoking rooms, etc., is of great luxuriousness. In addition to the other arrangements for the passengers, there is an elevator running through three decks and operated by an electric motor, while the installation on board of the wireless telegraph system permits the passengers to communicate with shore. All the apartments on the ship, without exception, are heated by steam, and the heat may be maintained in the separate radiators at a temperature of about 18 degrees Centigrade (62.4 degrees Fahrenheit). Certain of the principal quarters of the ship, in particular the first-class dining saloon, the ladies' cabin, and the apartments de luxe, are fitted in addition with electric fans.

LA PROVENCE AFLOAT.

The electric installation consists of four dynamos in two groups of two, each operated by steam turbines, and having a combined power equivalent to 300 Kw. They furnish current for a total of about 1,800 lamps. Current is also furnished by these dynamos to operate 49 large electric ventilating fans, four electric winches for hoisting the boats, and four electric capstans for handling the anchors, as well as the small electric fans, etc. The refrigerating machinery is situated aft of the engines and is so designed as to maintain in the cold chamber a temperature of —5 degrees Centigrade (23 degrees Fahrenheit). It operates on the Linde system, using liquefied ammonia gas.

The main engines are two in number, triple expansion, with surface condensers, and have each four cylinders developing a total of 30,000 horsepower, with which a trial speed of 23 knots is anticipated. The boilers are twenty-one in number, of the cylindrical type, having diameters respectively of 5.2 and 4.9



BOW VIEW BEFORE THE LAUNCHING.

meters (17 and 16 feet), and operated at a pressure of 14 atmospheres (206 pounds per square inch). They are fitted with Howden system of forced draft. There are two funnels, having a diameter of 5.2 meters (17 feet), and a height above the grate bars of 35 meters (115 feet). All of the auxiliary machinery is operated by steam or electricity. The total number of items is 135, of which 75 are steam driven and 60 electrically driven.

La Provence, as with the other large passenger steamers of this line, is arranged for service as an auxiliary cruiser of the French navy whenever occasion calls for its being placed in that service.

Mr. Andrew Olsen, formerly connected with the Townsend-Downey Shipbuilding Company, has formed the partnership of Olsen & Ainsworth, and has established a boat and launch business at Madison, Wis.

Mr. Charles A. C. Winther, for many years general superintendent of the Chapman Valve Manufacturing Company, has accepted the position of general superintendent of the Roe-Stephens Manufacturing Company, Detroit, Mich.

Foreign Types of Fishing Boats in San Francisco Bay.

BY E. N. PERCY.

The accompanying illustrations show types of boats which are unique for this country. The first is a Chinese junk patterned after the peculiar architecture in vogue in the *Orient*, where no other design has obtained much place since the time of Confucius. There are about 200 of these boats in and around San Francisco Bay, which are used by the Chinese fishermen to carry shrimps and supplies between their fishing villages on the bay and the city of San Francisco. The sail is a rectangular sheet of

CHINESE JUNK ON SAN FRANCISCO BAY.

canvas stiffened by lateral strips of bamboo placed about 2 feet apart. It is hung by the middle from the top of the mast and has neither boom nor gaff, nor does it need either. These junks cannot beat at all well into the wind, hence with an adverse wind they find it necessary to make long detours in order to reach their

ITALIAN FISHING BOAT.

destination. The bow and stern are made of a sort of crude bulkhead built of planks, to which the side and bottom planking are fastened with wooden pegs. The planking varies in thickness from 1 inch to 1 1-2 inches, and is comprised of such nondescript material as can be found at hand, or bought for the lowest figure. The deck is boarded over and battened much as one would roof a chicken-house or wood-shed. In the center of the junk is a cockpit about 12 feet long by 6 feet wide, in which the cargo is carried. Except for this cockpit, the junk is decked fore-and-aft and over the 18-inch space between the edge of the cockpit and the side of the boat. In rough or heavy weather a tarpaulin covers the entire hull.

The planking is supported by four constructions similar to transverse bulkheads, and these constitute the entire system of framing for the 30-foot length of the boat. The bottom is made nearly flat and has a small keel.

FISHERMEN'S WHARF.

On each end of the craft is a windlass of the very crudest description. The crew consists of six Chinamen, who live in a 5 by 5 hole in the stern. They steer with the tiller connected with the rudder through a rudder post. The rudder is about 3 feet square, dips 8 inches into the water, and is constructed of a single thickness of 1-2-inch pine boards. The cost of one of these craft complete is about $350. In building these boats the Chinamen use their time-honored custom of drawing both saw and

ANOTHER VIEW OF FISHERMEN'S WHARF.

plane toward them in the cutting stroke. Great care is necessary in docking the junks in order to avoid injuring their frail structures, as indeed a very small shock will suffice to cause an utter collapse.

In decided contrast with these Chinese junks are the staunch fishing boats used by the Italian fishermen on the bay. They are small, double-ended sail-boats of deep draft, carrying a lateen sail and equipped for emergency with a gas engine and propeller. The boats are decked over except for a small cockpit aft, and have a cozy cabin under the forward deck. The dimensions average 30 feet in length with a 6-foot beam, and a draft of from 2 to 3 feet. The Italians operating these craft go out into the Pacific for bass, halibut, and other deep-sea fish, and their fishing course extends over a wide area. They remain out in all kinds of weather for days at a time, and return only when they have obtained a heavy catch. The method of fishing seems to consist of placing buoys with lines and baited hooks, this requiring combined speed and endurance for effective results.

At the time of the sinking of the Pacific mail steamship *Rio de Janeiro* in the Golden Gate on the 22d of February, 1901,* these boats were of great assistance in recovering such of the bodies of the 131 who were lost as were not carried out to sea by the powerful tides. It was noted at the time that the men were extremely honest in the handling of such property as came into their hands, turning over to the authorities all the jewelry and merchandise of every description which they recovered. A recent trouble between two partners among these fishermen shows the childlike character of their nature. They decided that they could no longer remain in partnership, and proceeded to divide the property which was common to them. They cut in two with a knife all their seins and fish lines, as well as their chests, sails, and rigging, and then started to saw the boat in two in order that each might have half. This last operation was stopped by their friends, who showed them what a foolish thing they were trying to do.

The last two illustrations show "Fishermen's Wharf," where all of these boats land their fish and obtain supplies.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, report under date of July 10, 1905, the following percentage of completion of vessels building for the United States Navy:

BATTLESHIPS.			June 1	July 1.
Virginia	19 knots.	Newport News Co.	87.38	89.71
Nebraska	19 "	Moran Brothers Co.	72.4	75.
Georgia	19 "	Bath Iron Works.	80.01	82.66
New Jersey	19 "	Fore River Shipbuilding Co.	84.8	86.2
Rhode Island	19 "	Fore River Shipbuilding Co.	87.6	88.8
Connecticut	18 "	Navy Yard, New York, N. Y.	77.73	80.74
Louisiana	18 "	Newport News Co.	77.55	80.79
Vermont	18 "	Fore River Shipbuilding Co.	51.1	53.6
Kansas	18 "	New York Shipbuilding Co.	54.	55.1
Minnesota	18 "	Newport News Co.	65.42	68.
Mississippi	17 "	Wm. Cramp and Sons.	29.09	31.28
Idaho	17 "	Wm. Cramp and Sons.	27.18	29.57
New Hampshire	18 "	New York Shipbuilding Co.	7.2	11.2
ARMORED CRUISERS.				
California	22 knots.	Union Iron Works	76.2	78.3
South Dakota	22 "	Union Iron Works.	74.	76.1
Tennessee.	22 "	William Cramp and Sons.	75 73	79.4
Washington	22 "	New York Shipbuilding Co.	76.3	79.1
North Carolina	22 "	Newport News Co	6 03	9.14
Montana	22 "	Newport News Co	5.32	7.98
SEMI-ARMORED CRUISERS.				
St. Louis	22 knots.	Neafie and Levy Co.	65.3	67.4
Milwaukee	22 "	Union Iron Works.	73.8	75.2
Charleston	22 "	Newport News Co.	94.98	97.
GUNBOATS.				
Dubuque	12 knots.	Gas Engine and Power Co.	99.4	100.
Paducah	12 "	Gas Engine and Power Co.	85.4	88.9
TRAINING SHIPS.				
Cumberland	Sails.	Navy Yard, Boston.	95.	95.
Intrepid.	"	Navy Yard, Mare Island	97.5	97.5
TORPEDO BOATS.				
Goldsborough	30 knots.	Wolff and Zwicker.	99.	99.
O'Brien.	26 "	Lewis Nixon	99.	99.

*See Marine Engineering, page 127, April, 1901.

MOTOR BOATS.

BY DR. WILLIAM F. DURAND.

THE GAS ENGINE.—(*Continued.*)

Two-Cycle Engine: By a somewhat different mechanical arrangement of the engine it is found possible to condense the essentials of the cycle into two strokes instead of four, and thus to obtain one power stroke every revolution of the engine instead of every two revolutions, as in the four-cycle engine.

The operation of this engine may be explained by the aid of Fig. 7. The crank case, as here shown, is inclosed gas-tight and provides in effect a closed extension to the lower end of the cylinder. In *a* the piston is at the top of the stroke. During the preceding up stroke a fresh charge has been undergoing compression above the piston and at the instant shown in the figure is ready for firing. During the same up stroke another fresh charge has been drawn into the crank case through the inlet valve. At the instant shown in *a,* then, the gas has reached its

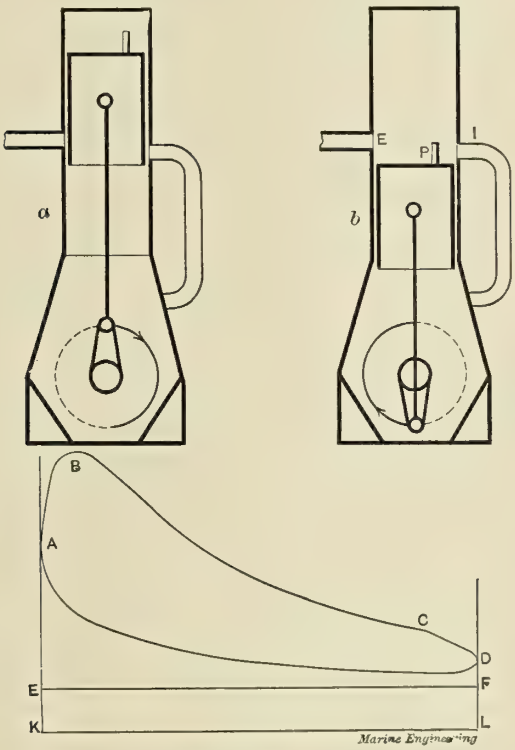


FIG. 7.—TWO-CYCLE ENGINE, WITH INDICATOR CARD.

highest compression pressure as indicated by the point *A* of the diagram. The charge is then fired, the pressure rushes up to *B* and the piston is urged along the down or power stroke under the action of the expanding gas in the same manner as with the four-cycle engine. This entire operation is indicated by the line *ABC* of the indicator card. Toward the end of the stroke the piston uncovers the exhaust passage *E,* Fig. 7*b,* exhaust begins, and the pressure drops as shown by the line *CD.* An instant later the piston uncovers likewise the inlet passage *I,* and the fresh gas which has been compressed in the crank case during the down stroke now finds relief by expansion into the cylinder through this passage. A deflecting plate *P* is commonly fitted on the piston, as shown, in order to deflect upward the incoming charge, and prevent its short-circuiting across direct to the exhaust passage. This deflection of the inflowing gas is also useful as a means of chasing or scavenging the spent gases out of the cylinder, and thus realizing substantially a cylinder full of fresh gas for each power stroke. These various operations are supposed to take place while the piston is moving slowly near the end of the stroke. As the piston begins to return it shuts off first the inlet and then the exhaust passage, the escape of the spent gases being then supposed to be complete. Actually, the events cannot be quite so accurately timed, and in practice either some little spent gas will still remain in the cylinder or some of the fresh charge will escape. However, with the charge in whatever condition it may be found at the closure of the exhaust passage, the piston continues its upward stroke, compressing the gas as shown by the line *DA* of the diagram, and thus preparing for the firing point at the beginning of a new cycle.

In analyzing the work of the cycle it will be clear, fixing our attention on the gas above the piston, that the work done *by* the gas on the down stroke is represented by the area *KABCDL,*

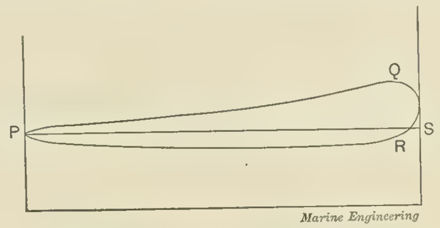


FIG. 8.—CRANK CASE DIAGRAM.

while that done *on* the gas during the up stroke is represented by *KADL.* The net work for the space above the piston is thus shown by the area *ABCD.* But this is not all. In the two-cycle engine with its closed crank case the pressure of the gas below the piston is not the same for each stroke. An indicator attached to the crank case would in fact show a diagram similar to Fig 8. The line *PQ* shows the compression in the crank case during the down stroke, reaching a maximum value at *Q,* just before the opening of the inlet passage as above described. The pressure then equalizes with that above the piston at a value slightly above the atmosphere, and then as the piston reverses its motion and begins its up stroke the pressure falls slightly below that of the atmosphere, where it remains during the stroke as shown by *RP.* The net work done *on* the gas in the crank case is therefore shown by the area *PQR.* The actual net work of the cycle will therefore be given by the difference between these two diagrams.

In Fig. 9 is shown the analysis of the pressures above and below the piston for each stroke after the manner of Fig. 6. Work done *on* the gas is shown by hatching inclined downward to the right, and work done *by* the gas by hatching inclined downward to the left. The singly hatched area *ABC* shows then the net work done by the gas from the beginning of the stroke up to the point *C,* while the singly hatched area from *C* to the end of the cycle shows

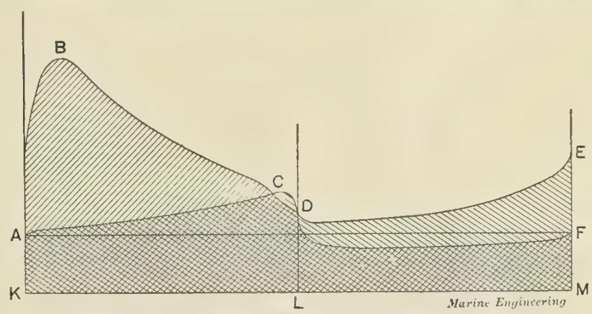


FIG 9.—DISTRIBUTION OF WORK IN TWO-CYCLE ENGINE.

the net work done *on* the gas during the rest of the cycle. That from *C* to *D* is done on the gas below the piston and that from *D* to *EF* is done on the gas above the piston while on the compression stroke.

Crank Effort. A further point of importance arises in connection with the turning effort on the crank and its relation to the crank angles when several engines are coupled to one shaft. Taking first the four-cycle engine and referring to Fig. 10*a,* let the strokes be numbered *1, 2, 3,* and *4* and indicated as shown, and let No. *3,* indicated by the heavy line, be the power stroke. Then it is easily seen that in order to obtain a power stroke and turning effort every other stroke, a second cylinder (b) must be provided with its cycle displaced two strokes from that of (a). The strokes for two cycles may then be represented as in the diagram, the numbers referring solely to (a). Then remembering that the heavy line represents the power stroke in each engine, it will be seen that such stroke occurs once a revolution in one cylinder or the other, and hence that with this arrangement we obtain continuously one power stroke per revolution of the shaft. It is easily seen further that the cranks of both engines must lie in the

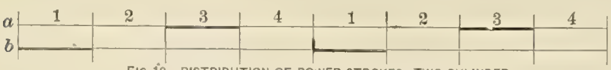


FIG. 10. DISTRIBUTION OF POWER STROKES, TWO CYLINDER FOUR CYCLE ENGINE WITH CRANKS TOGETHER.

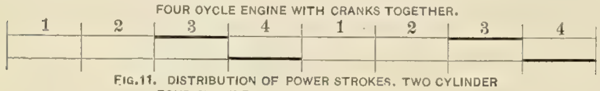


FIG. 11. DISTRIBUTION OF POWER STROKES, TWO CYLINDER FOUR CYCLE ENGINE WITH CRANKS OPPOSITE.

Marine Engineering

same direction and not opposite, as might at first thought have been expected. With two cranks opposite, and using the same mode of representation, it is seen that the distribution of power strokes will be indicated by the diagram of Fig. 11. This shows power strokes or turning effort on two successive strokes, and then two strokes without power or turning effort. This is obviously a less desirable arrangement, so far as turning effort is concerned, than that with the cranks together as shown in Fig. 10. On the other hand, this same arrangement is much the more desirable so far as running balance is concerned. With the cranks together the engine by itself is entirely out of balance and such arrangement without counterbalance would be out of the question. It therefore becomes necessary in the two-cylinder engine either to fit counterbalance weights on the crank shaft, involving their extra weight and expense, or to adopt the arrangement of Fig. 11 with its irregular distribution of power strokes through the complete cycle. The latter is the arrangement usually adopted by builders of the two-cylinder four-cycle type of engine.

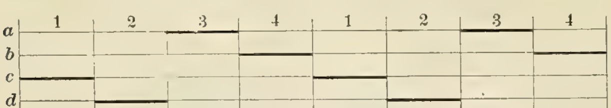


FIG. 12. DISTRIBUTION OF POWER STROKES, FOUR CYLINDER FOUR CYCLE ENGINE WITH ALL CRANKS IN ONE PLANE.

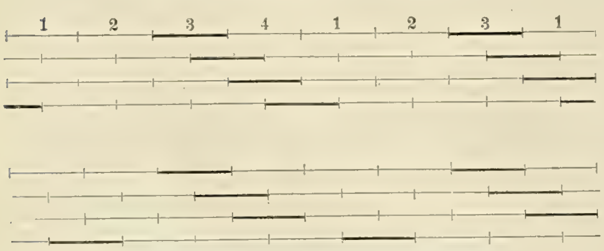


FIG. 13. DISTRIBUTION OF POWER STROKES, FOUR CYLINDER FOUR CYCLE ENGINE WITH CRANKS AT 90 DEGREES.

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In a similar manner it is seen that if we combine four cylinders successively one stroke apart, as indicated in Fig. 12, we shall obtain a power stroke in one cylinder or another for every stroke of the engine. It is also seen that the cranks will all lie in one plane, those for (a) and (c), for example, being up with their pistons at the top of the stroke when those for (b) and (d) are down with their pistons at the bottom of the stroke. So far as turning effort is concerned it is seen that this arrangement of cranks is equivalent to a single-cylinder steam engine with steam acting in the usual manner on both sides of the piston.

The question naturally arises regarding the distribution of power strokes in the case of four cranks at right angles successively around the circumference, as in the common type of four-cylinder marine steam engine. There might be several arrangements, of which two are indicated in Fig. 13. The successive strokes follow at intervals of one-half stroke between cylinders, corresponding to the 90 degree crank angle, and it is seen that the power strokes, indicated by the heavy lines, overlap in amounts varying with the arrangement, thus concentrating the power into a certain part of the entire cycle and leaving the remainder without turning effort. From this viewpoint, therefore, all such arrangements are inferior to that indicated in Fig. 12.

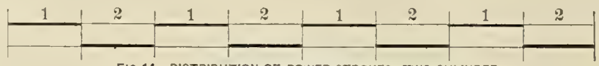

FIG. 14. DISTRIBUTION OF POWER STROKES, TWO CYLINDER TWO CYCLE ENGINE WITH CRANKS OPPOSITE.

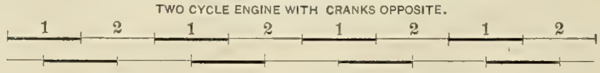

FIG. 15. DISTRIBUTION OF POWER STROKES, TWO CYLINDER TWO CYCLE ENGINE WITH CRANKS AT 90 DEGREES.

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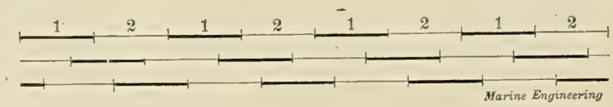

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FIG. 16.—DISTRIBUTION OF POWER STROKES, THREE-CYLINDER, TWO-CYCLE ENGINE, WITH CRANKS AT 120 DEGREES.

With the two-cycle engine the combinations are similarly shown in Figs. 14, 15. In the former with cranks opposite the power strokes alternate between the two cylinders, so that on one or the other there is a power stroke for every stroke of the engine. This combination is therefore equivalent to the four-cylinder four-cycle arrangement indicated in Fig. 12, or to the common single-cylinder steam engine.

In Fig. 15 the arrangement with cranks at 90 degrees is shown. It is clear that here the power strokes overlap for a half stroke in one part of the cycle, leaving an equal period in another part without power or turning effort. The correct arrangement as regards turning effort is therefore that indicated by Fig. 14 with the cranks opposite.

It is also of interest to note that the equivalent of a two-cylinder steam engine with cranks at 90 degrees would require an eight-cylinder four-cycle or a four-cylinder two-cycle engine, the former being arranged in two groups of four cylinders each, and the latter in two groups of two cylinders each, all cranks in one group lying in the same plane, and the plane of the two groups lying at 90 degrees with each other.

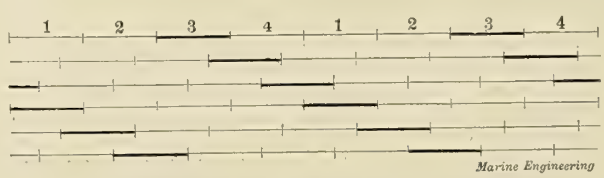

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FIG. 17.—DISTRIBUTION OF POWER STROKES, SIX-CYLINDER FOUR-CYCLE ENGINE, WITH CRANKS AT 120 DEGREES.

Engines with three and with six cylinders, and with cranks at 120 degrees, are also found in the practice of the day. These permit of an excellent running balance and of a very satisfactory distribution of crank effort throughout the revolution. Various arrangements of power stroke are possible, but the most satisfactory are indicated in Figs. 16 and 17 respectively for the two- and four-cycle types.

General Comparison. In a general comparison between the two- and four-cycle engines the following points may receive consideration:

(a) For a given size of cylinder, length of stroke, and revolutions per minute, the two-cycle engine will give more power than the four-cycle. If the same amount of gas of the same quality could be burned in each cylinder and if the energy developed could be used with the same efficiency, or in other words if the gas could be used with the same thermal and mechanical efficiency in both engines, then, since the two-cycle engine gives twice the number of power strokes in the same time, it is clear that it would develop twice the power of the four-cycle. Actually, however, the ratio is slightly less than two to one, varying with the special circumstances of the case. Under reasonable conditions, however, the two-cycle engine may be depended on to give from 75 to 80 or 85 percent of power in excess of the four-cycle for the same size and revolutions.

The failure of the two-cycle engine to develop under like conditions fully twice the power of the four-cycle is due chiefly to the difference in the control over the mixture in the cylinder. The waste gases are chased out of the cylinder in large measure by the incoming fresh gas, and this cannot be accomplished without some intermixture of the two, and this must result either in undue dilution of the charge if the exhaust is closed too soon or in the escape and wastage of part of the fresh gas if the closure of the exhaust is delayed. In the general case, therefore, the quality of the gas mixture is not under as definite control in the two-cycle as in the four-cycle engine, and this will react unfavorably on the amount of work which can be obtained per power stroke. During the non-power strokes the work involved in what may be termed handling and preparing the gas for the power stroke is presumably about the same in both types of engines.

As regards engine friction the two-cycle engine has somewhat the advantage over the four-cycle. In the former the friction of two strokes is charged against the power stroke, while in the latter the friction of four strokes must be thus charged. It results that in the latter as compared with the former the friction of two extra strokes must be charged against the one-power stroke of the complete cycle.

As a combined result of these various relations, the two-cycle engine shows, as above stated, an advantage in power developed of from 75 to 85 percent for the same size of cylinder and revolutions per minute.

It follows, of course, that for a given power required the two-cycle engine will show a marked saving in weight and space occupied as compared with the four-cycle type.

(*b*) With engines of the same general size and working under the same general conditions, the four-cycle type is found to be somewhat more economical in operation than the two-cycle. This means more power per cubic foot of gas, or per pound or gallon of fuel. This superiority is due primarily to the more perfect control over the quality of the mixture in the cylinder, and the more perfect thermal cycle for the gas in one case than in the other, and as discussed above in reference to the relation between the amounts of work in the two types of engine.

(*c*) Speed variation is somewhat more easily controlled with the four- than with the two-cycle engine. The various ways of effecting such control will be referred to at a later point, but in this general comparison it will be fair to point out that for widely varying speeds the four-cycle type will be found the better adapted. This again is due to the more definite character of the operations in the four-cycle type, and to the better control which may thus be exercised over the resultant charge of fresh gas.

(*d*) A more uniform turning moment may be obtained from the same number of cylinders working on the two-cycle plan than on the four-cycle plan. This will be readily seen by referring to the preceding discussion of power strokes and turning effort in multi-cylinder engines.

(*e*) A somewhat smaller flywheel is required with the same number of cylinders working on the two-cycle plan as compared with the four-cycle plan. This follows from the more uniform turning moment as noted in (*d*) above.

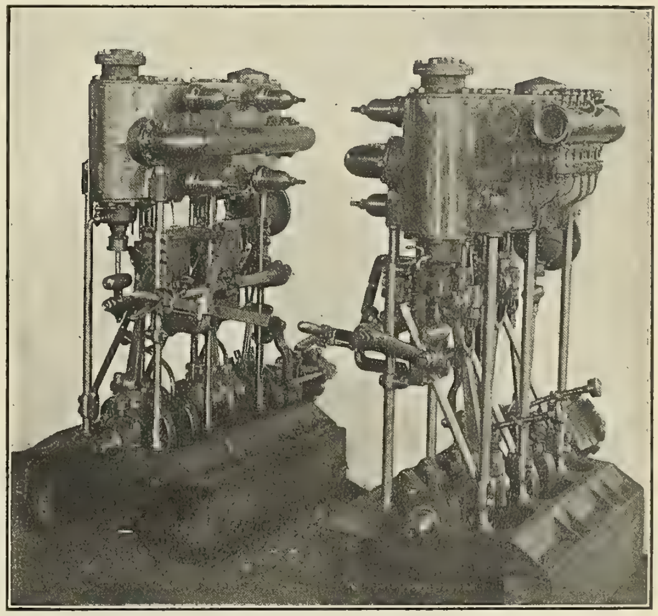
(*f*) The two-cycle engine more readily gives a combination of smooth turning moment and running balance. This will be readily seen by a detailed comparison of multi-cylinder engines using the graphic method of Figs. 10-17.

(*g*) High revolutions, if desired, are somewhat more readily realized and regularly maintained with the four-cycle than with the two-cycle type.

(*h*) The general trend of engineering opinion and practice justifies the conclusion that the four-cycle type is on the whole to be preferred for engines of any considerable size or power, or when economy of operation is of special importance, or where very high speeds of revolution are desired, and in general with reference to durability, reliability, and certainty of operation and control. On the other hand there is an undoubted field for the two-cycle engine in small sizes and where light weight, compactness, simplicity, and low cost of construction are considerations of special importance.

Having thus considered the general character of these two types of marine internal combustion motors, we shall, in the next chapter, take a nearer view of such motors as they are actually found in the leading practice of the day.

(To be continued.)



Compound Engine of the Shallow=Draft Steamer Macuspana.

We show herewith a photograph of the compound engine of the *Macuspana*, which boat was described in MARINE ENGINEERING for November, 1904, on page 518. There are two of these engines, operating twin screws and having cylinders 4 1-2 and 9 inches in diameter with a stroke of 6 inches. The piping is arranged so that the engines may be worked either together or independently, the total horsepower of the two engines being about 50. The crank shafts, connecting rods, valve, eccentric, and piston rods are all of the best open-hearth mild steel, while crossheads, "brasses," receiver pipe, relief valve, and stuffing glands are of naval gunmetal. The reversing gear is of the spiral type, the spiral arrangement being located on the crank shaft at the after end of the engines. The high-pressure valves are operated from a rocker shaft, as shown. The cylinders are covered with polished brass lagging. Boat and engines are from the works of the Racine Boat Manufacturing Company, at Muskegon, Mich.

Mr. Ralph M. Parsons, of Chicago, has purchased the interest of his partner, Mr. John G. Kreer, and will continue the business of building shallow-draft boats, etc. Mr. Kreer has joined Mr. D. B. Southard, and will take the Chicago agency for several well-known launch, gas engine, and other concerns.

At page 242 of our issue for June appeared an article translated for us, which, we neglected to state, was published originally in *Schiffbau*.

The Steamship Crown of Castile.

BY BENJAMIN TAYLOR.

The new steamer *Crown of Castile,* built by David and William Henderson and Company, Limited, Glasgow, for the West Indian "Direct Line" of Prentice, Service and Henderson, of the same city, is an excellent example of a high-class cargo vessel, with passenger accommodation. She has been designed and constructed with the object of providing the best possible facilities for handling cargo. The principal dimensions of the vessel are: length, 400 feet; beam, 53 feet 2 1-2 inches; and depth, 28 feet 4 inches; she has a carrying capacity of 10,000 tons measurement and 7,200 dead weight. The *Crown of Castile* is propelled by a set of triple-expansion engines, constructed by Messrs. Henderson, and having cylinders 27, 46 and 76 inches in diameter, with a piston stroke of 48 inches; these are supplied with steam at 180 pounds pressure by four single-ended multitubular boilers 15 feet 9 inches in diameter and 11 feet long, each having three corrugated furnaces 3 feet 11 inches in diameter. In the engine room there is a complete outfit of auxiliary machinery including Weir's feed pump, Weir's evaporator of 20 tons capacity, electric lighting plant, and steam steering gear, the latter supplied by Caldwell & Company, of Glasgow.

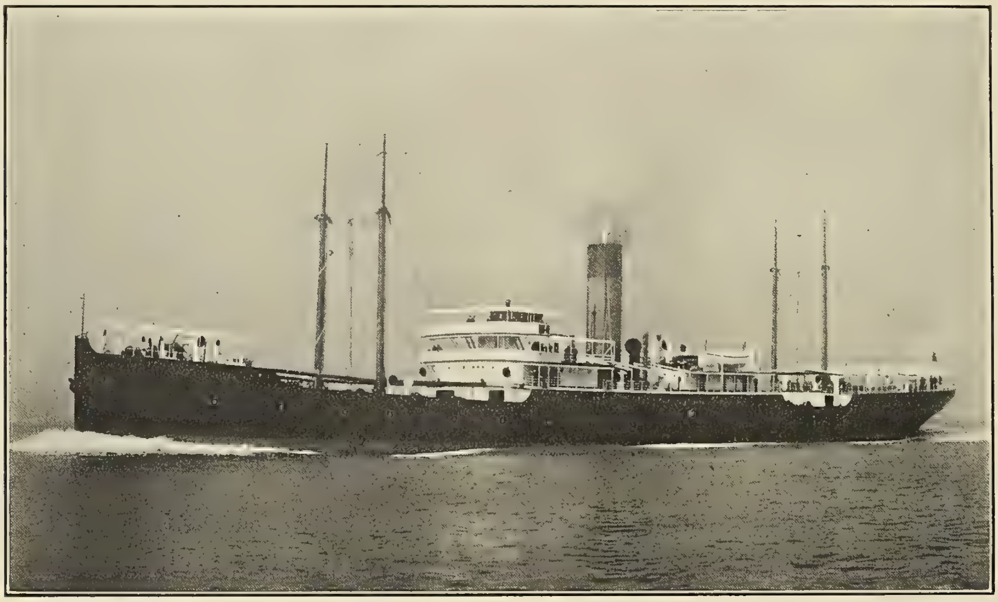
A distinctive feature of the *Crown of Castile* is her rig and cargo gear, which consists of four pole masts placed in pairs about 24 feet apart athwartships, each carrying two derricks, one of which works forward and one aft. In this way a much greater overside swing of derrick may be obtained than with single masts, and cargo can be landed in the outer of a double row of barges lying alongside, or where necessary, the cargo can be landed direct into railway cars. The steam winches for working these derricks are nine in number, extra heavy, with large bearings, and are of Messrs. Henderson's special construction, having cylinders 7 inches in diameter by 12 inches stroke, and short barrels 22 inches in diameter for quick hoisting with wire rope. Each derrick is capable of working loads of ten tons, while a special heavy derrick is fitted capable of dealing with loads of thirty tons. When loading the vessel prior to her departure from the Clyde this gear was well tried and found to work perfectly, and the loading was done in record time.

Another feature of this steamer is the superior accommodation for a number of first-class passengers, which is fitted in a large steel house at the fore end of the bridge deck. This comprises a large airy saloon tastefully fitted in light polished oak, in which dining accommodation is provided for fourteen persons. Off this access is given to six well ventilated two-berth state rooms, and in the same house are placed the bath rooms, steward's room, pantries, and store rooms. Over this house, and communicating with it by an inside stair, is the captain's room, and a comfortable smoke-room for passengers.

The ship's officers and engineers are accommodated in large rooms on either side of the engine casing at the after end of the bridge deck. This accommodation is fitted throughout with electric lights and bells.

On April 15, having completed loading at Glasgow, this vessel proceeded down the Clyde for speed trials, when a mean speed of 12.8 knots on the measured mile was obtained, everything working in a most satisfactory manner. After picking up a number of passengers she proceeded on her first voyage to the West Indies

The *Crown of Castile* will shortly be followed from the yard of the same builders by her sister ship, the *Crown of Aragon,* and the two will form a valuable addition to the regular service of the "Direct Line" between the United Kingdom and West Indian ports.



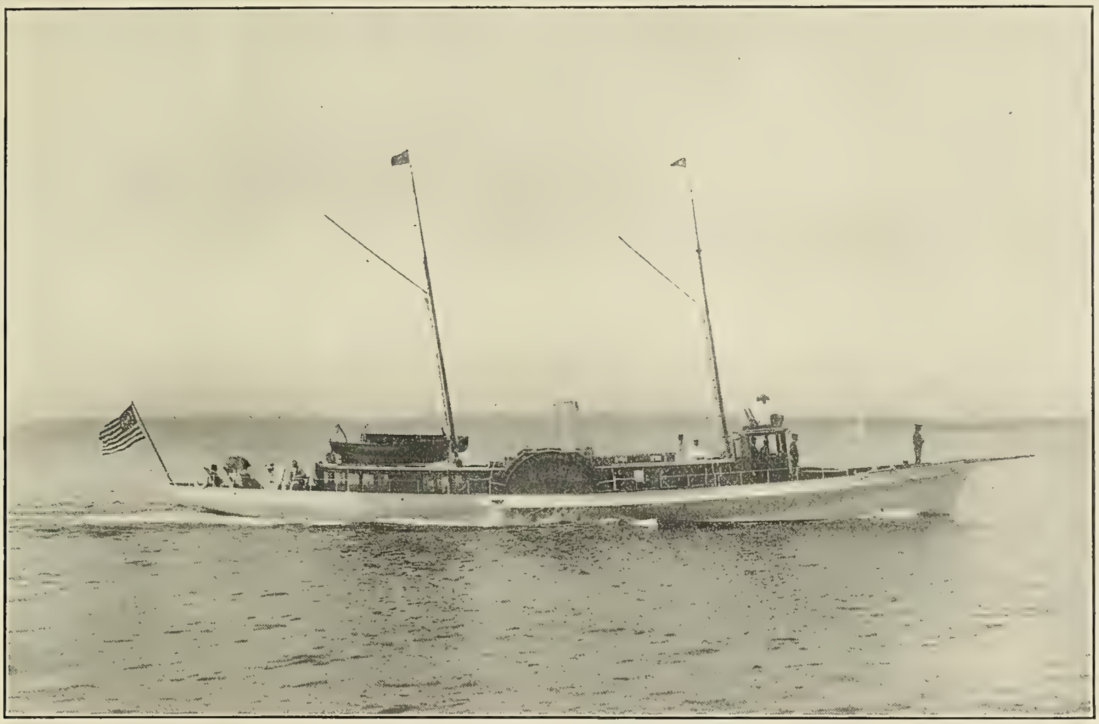
THE CROWN OF CASTILE ON TRIAL TRIP.

Paddle-Wheel Yachts.

According to the tables given in *Manning's Yacht Registry,* there are left in the United States at the present time only four steam yachts operated by paddle-wheels. Of these four, two are unrigged, and the other two, which we illustrate herewith, are both rigged as two-masted schooners. The larger of the two, which was the *Clermont,* belonging to the estate of A. Van Santvoord, of New York, measures 175 feet length over all, 165 feet on the water-line, has a beam of 25 feet 6 inches, a depth of 10 feet 5 inches, and a draft of 5 feet 6 inches. Her gross tonnage is 299 and net 203. Designed by Mr. Van Santvoord, and built by H. Lawrence, of Greenpoint, New York, this yacht was launched in March, 1892. She is propelled by a surface condensing beam engine, having one cylinder 40 inches in diameter with a 72-inch stroke, and operated by steam furnished by a flue and return-tube boiler, both boiler and engine having been constructed by the W. & A. Fletcher Company, Hoboken, N. J.

This yacht has recently been purchased by Mr. Charles G. Gates, of New York, and renamed *Charmary.*

The other yacht which we illustrate is the *Turtle,* belonging to Mr. Arthur Amory, of Boston, Mass. She measures 89 feet 2 inches over all with a water-line of 80 feet. The beam is 19 feet



PADDLE-WHEEL YACHT TURTLE.

11-4 inches; depth, 5 feet 9 inches; and draft, 3 feet 4 inches. Her tonnage is 37.5 gross and 23.6 net. She was designed and built by Allan Hay, of Lynn, Mass., in 1889. She is propelled by a two-cylinder compound oscillating engine, the cylinders measuring 9 and 17 inches respectively in diameter with a stroke of 20 inches, this engine being built and installed in 1893 by George E. Whitney. Steam is furnished by an Almy water-tube boiler installed in 1898.

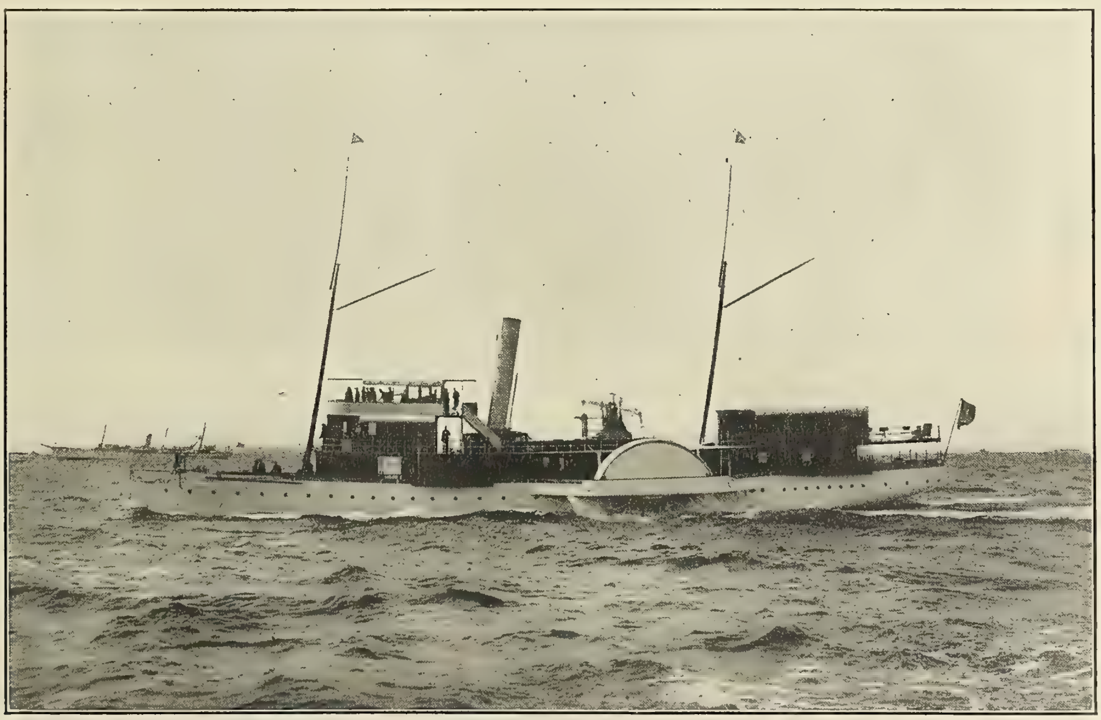
The two photographs were taken by Mr. N. L. Stebbins, of Boston.

Log Book of a Whaler, 1834-1837.

Extracts.

Mr. Andrew Snow, Jr., New Bedford, Mass., recently left at the office of Marine Engineering, for examination, a very interesting old log book. It is the ordinary rough log, about 13 by 20 inches in size. The paper has been roughly ruled by pen and ink, and the log itself is bound in heavy canvas. It describes the voyage of "ship *Barclays* on a whaling voyage to the Pacific ocean, Captain Henry Carttel, master."

Whenever a whale is caught, a crude impression of a picture of



YACHT CHARMARY, FORMERLY CLERMONT.

a whale is stamped on the page, evidently from a wooden block, the surface of which has been covered with ink. When a whale is chased but lost, a picture is given of the whale "flukes up"—that is, only the tail showing. The boat capturing the whale is given credit on the margin of the log, and the amount of oil is also recorded. Thus: "starboard bow boat, 65 bbls." As shown by the dates, the voyage began September 13, 1834, and ended September 27, 1837. The following extracts from the log give an idea of the whole, but leave out much detail of the itinerary around Cape Horn and among the islands of the Southern Pacific ocean.

The first entry is dated Sep. the 13th 1834

Saturday on board; Now, Lying at anchor, Bedford Harbor below palmers Is 5 fathoms of Water first part (of the day) of these 24 hours strong Breezes from the N W the weather fine most of the Crew on Board employed Ships Duty mid part (of the day) light airs from the N W Latt part a fine Breeze from the N at 5 oclock the Pilot come on board Commensed heaving a head at six oclock Broke ground and Bid a Due to the Land We all so much admire but with the hopes of a Short Voyage we set all sail at 9 oclock the pilot left us steered out S W at 11 oclock the wind shifted to the East from that to S E we steering to the S W at 12 oclock to Gayhead light House Bore E 1-2 N Dist 8 Miles the No mans Land Bore E S E—saw number of Vesels steering different Coursees so Ends this day with unpleasant Fealings . . . Sweet Home

. . . .

Monday Oct the 6th

Commenseed with fine Weather and light Winds from the South we with all sails set one Brig insight at 2 oclock Lowered our boats to exersize the Crew which was very necesury at Supper While in the act of Shareing the vittals forward one of the Crew began to fight with some of the Green hands it being the third time we put him in Rigging Not intending to flay him, but his Sausy tung causeed him a few stripes with fore parts of a smal eadline affter wich he acknowledge that he was to blame we then let him goe forward where he made nomber threats this promising youths name is Bradford Tiafford . . . Mid part light airs from south the Black Smiths very sausy he being the worse for Rum Latt Part calmer lowered the Boats and chaseed Grampass for Whales

. . . .

The Remarks on boad wednesday Oct the 8th

This day begins with strong Winds at N E and squaly we with all sail set steering to the ese all Hands Emp in Ships duty pasta Schooner steering to the N W Mid part Dubble Reefed the topsails took in the jib and spanker Latt Part much the same accomed with bad sea one watch below the rest Employed in Domestic duty Nothing to be seen but the wide Ocean our old Rigging parts very often it is not other wise to be Expected so ends this long and Dismal day in hopes of a fare one

. . . .

Remarks on Sunday Oct the 12th

begins with fine weather and strong winds all hands Emp at 3 oclock saw a Shoal of Sperm Whales a Going to the S E lowered our Boats and got one of them 30 bbls at 5 oclock took him a longside took in sail and lay by for the Night Mid Part employed in Geting Redy for Cuting latt Part at day light commensed Cuting at 9 oclock finshed wind to the N E the weather fine Com Boiling

. . . .

November Monday the 3th Cape Verds I

First part of this day strong traids at E N E all set steering S by W at 2 oclock saw the Iland of saint Nicholas Bairing S by W the east point by Compas dist 50 M at sunset it bore the same dist 30 Miles and st Anthony south point bore West Mid part took in the light sails steered S by w at 12 oclock the Iland of Saint Nicholas bore N W by W dist 20 miles Latt Part at daylight saw st Jago ahead steered for it at 9 o'clock saw the Isls of May Run down the west side of it within 8 miles saw a ship and schooner abeating up to the harbor so ends (the day) with south point bairing N E dist 20 miles

. . . .

December Thursday the 25th

First part agail from the Eastward dubble reef the topsails Mid Part calms and light airs Latt part a Fine Breeze from the N W set all sail steered S E the weather fine and clear saw a Number of finbacks the Water very Green thus ends

. . . .

(Neither Christmas nor New Years are observed in any way according to the records, and evidently there was no opportunity for observing New Years, as "Heavy gails" lasted for days as the ship passed round Cape Horn. Weeks passed and life was very monotonous, and according to the log no whales were either caught or seen.)

. . . .

Callao Wednesday February the 18th

Begins with fine weather light winds from the S we steering North for the Iland of Lorenzo at 1 oClock saw it Bairing E N E Dist 22 M at Sunset it Bore S E dist 7 Miles Bent the Chains Got Ready for Anchoring. Mid Part light airs and Calms thick Fog at 11 Oclock Came to anchor in 10 Fathoms of Water 3 Miles Below the Shiping Latt Part at Daylight took our Anchor and Beat up to the Shiping with alight Breeze from the S by 8 oClock we Anchored In the Harbor of Callao in 7 fathoms water the West Casttle Bairing S W by S dist one Mile hear we found the ship *Barclay* off Nantucket with 1300 bbls Bound Home three Men of War and a Number of Merchantmen at 10 oclock Sent on Shore a Raft of Cask for Water thus Ends all Hands Employed

. . . .

Saw Whales for the First time this side of the iland and Got None Is this Not hard for the Poor. April Friday the 17th

Begins with strong winds from the S E we steer S W by S at three Oclock saw a shoal of Sperm Whales a Goeing to the windward quick Lowered the Boats and Chaseed them till Sunset and then Come on Board down in the Mouth Mid Part lay with the Main top sail to the mast Latt Part steered S W at 9 Oclock Saw 2 Ships a head Run for the one of them a Cutting at 12 oclock saw a Whale Breech to leward of them ran for it thus Ends this day

. . . .

(The log continues for weeks and weeks, describing each day's doings of the voyage, and the occasional picture of the "flukes" of a whale show that a number were chased but lost. Occasionally there is a crude picture of a whale stamped against a day, showing that one had been caught.)

. . . .

October Sunday the 25th

Begins with strong breezes We Employed a Cuting In the side Whale (which was caught the day before) at 2 finished and steered our Course West at 4 Oclock saw more whales at 5 lowered the boats from boath Ships struck one Whale and Got him took him to the *Ann* (a Nantucket ship which was in company with the *Barclays*) Mid Part lay by Latter Part the *An* finished Cuting Steered of W S W Boath Ships at 10 oclock saw More Whales Lowered the Boats from boath Ships Struck one through our Ship and Got him at 12 oclock took him a longside thus Ends the *An* in Chase of the Rest (the stamp shows that the St. Boat caught a 60 bbl whale and the S Boat at 40 bbl. whale.)

. . . .

November Sunday the 22 Runaways

These 24 Hours begins with fine weather and strong breezes from the S E Moast of the Crew on Liberty Mid Part Calms Betwixt 8 and 9 oclock While the Capt Was out of the ship the Third mate George Coffin Took the Boat from a Longside with out Liberty and Went on Shore Takeing with him all of his Cloathe with him and One of the Crew by the name of George W.

Crocker this is Not unexpected for it has long ben talked of by Coffin Mid Part Calms Latte Part the Winds Light one Watch on liberty sent the Natives in Search of the Sweet Deserters thus Ends this and no Tidings of them and I hope there never will be again of the Third mate

. . . .

November Monday the 23th More Deserters

now begins with Fine Weather and light Breezes from West one Watch on Shore on Liberty at 7 Oclock the Liberty men Come of with the Exceptions of David Dupar and Edward Mich who has Deserted the Ship Mid Part Calms Latter Part light Westerly Winds one Watch on Shore; Got of 10 bbls of potatoes thus Ends and (no?) News of the 4 deserters as yet

. . . .

April Friday 29th Notice this

This begins with Strong Breezes from the E N E We Steering to the S E all sails Set Nothing insight at 3 oclock took the Winds from the E tacked Ship to the N N E Mid Part Winds at S E steered up E N E Latter much the same at 8 oclock the Capt sent the steward forward to Call the Men aft or one of them to se their Meat Weighed; but their reply was that they would not come, this was told the Capt, he immediately Called to them to come aft and repeated it three times and then went after them and took a Broom at one of the Blacks they all refused to *go* aft but sent one their complaint was that one pound and 1-4 of Meat was not enough and were very insolent and made their threats they Now went Forward not wishing to se their weight of meat; the said Black was insolent to the Capt when Coming forward but was called to Go aft again his reply was that he would *not* and fled for the fore Castle while Getting him up one of the Men Henry Ketchum came at the Gangway and interfered and Challenged the Capt and struck him at this the Capt took hold of him and dropped his wepon the Fellow took it up and maid an atempt to strike the Capt with it from this he was told to go Aft but refused and went Down the Fore Castle took a sheath kife and said he would kil the first Man that went Down but afterward delivered him self up to be put in Irons where now remains in the Run Thus Ends in peace

. . . .

On "September Monday the 25th 1837" the ship was within two days of Buzzard's Bay on her return home. According to the log this day:

Begins with fine weather Calms saw a Number of whales Mid Part light airs from the N E all sails set steering by the Wind to the N N W Latter part much the same saw one ship and 2 brigs steering to the N W thus ends with light airs from the east

September Tuesday the 26 1837

this commensed with fine pleasant weath and light breezes from the S E and South all sails set saw a number of whales and Finbacks Mid Part strong Breezes at S W steered north N by W and North at 2 oclock Sounded Got 30 fathoms of Water hove 2 with the Main yard aback north N N W at 9 oclock the said George Wingate (to whom the log makes no reference under previous dates) Departed from this Life; Latter Part at 4 steered of N E by E saw a number of small vessels at 8 oclock came to wind with the Main yard aback and Commited the said Corps to the deep at half past 8 steered again at 9 oclock took a Pilot Block I Bairing W S W Dist 25 Miles steered off again N E at 12 oclock Dumpling Light house bore N E Dist 5 Miles thus Ends this Joyful Day

September Wednesday the 27th

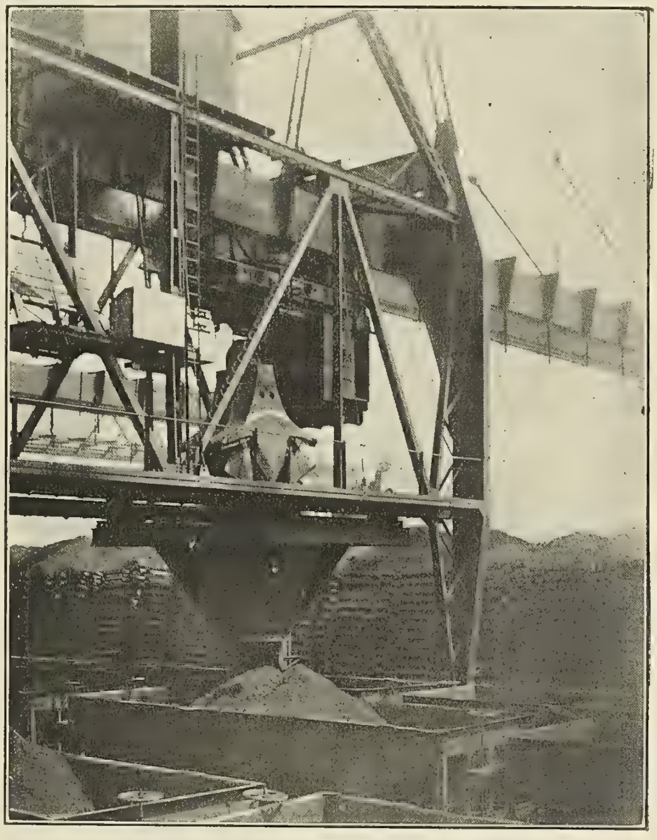
Begins with strong Breezes from the S W at one oclock passed the lighthouse at 2 Came to New Bedford in the Inner Roads Furled the sails thus Ends a voage that has been full of errors from the begining to the End

---

A record of the voyages of the ship *Barclays* follows:

Sailed.	Returned.	Ocean.	Captain.	Sperm Oil. Barrels.	Whale Oil. Barrels.
Aug., 1797..	June, 1799..	Pacific	Griffin Barney....	700	500*
Oct., 1799..	June, 1801..	"	" "	....	....
May, 1803..	Nov., 1804..	Indian.......	Randall...........	1.200	....
May, 1809..	May, 1811..	Pacific	Gideon Randall..	2.000	....
Nov., 1811..	Mar., 1814..	"	" "	1 800	....
July, 1815..	Nov., 1817..	"	Coffin	1.950	....
Jan., 1818..	Oct.. 1820..	"	"	1,600	....
April, 1821..	April, 1824..	Japan.......	Glover............	1,600	...
June, 1824..	April, 1825..	Brazil	Peter Coffin.......	160	1,600
Aug., 1827..	Oct., 1830..	Pacific.......	Sam Barrett......	1,858	....
April, 1831..	June, 1834..	"	Alex. Coffin, 2d...	1,200	....
Sept., 1834..	Sept., 1837..	"	Henry Cottle......	1.362	....
April, 1838..	April, 1840..	Indian.......	Swain............	165	1,939
July, 1840..	Mar., 1843..	"	Briggs	191	1,685 *a*
Dec., 1843..	July, 1844..	Pacific.......	Grinnell..........	....	....
July, 1844..	Jan., 1850..	"	Mann............	850	....
May, 1850..	April, 1852..	Atlantic and Indian.	Taber............	994	....
July, 1852..	April, 1854..	Atlantic....	A. P. Taber.......	728	365 *b*
Aug., 1854..	Aug., 1857..	Atlantic and Indian.	A. J. Fuller.......	410	1,016 *c*
				18,768	5.605

* Also 21,000 seal skins.
a Also 13,200 pounds of whalebone; *b* 2,400 pounds; and *c* 2,100 pounds.



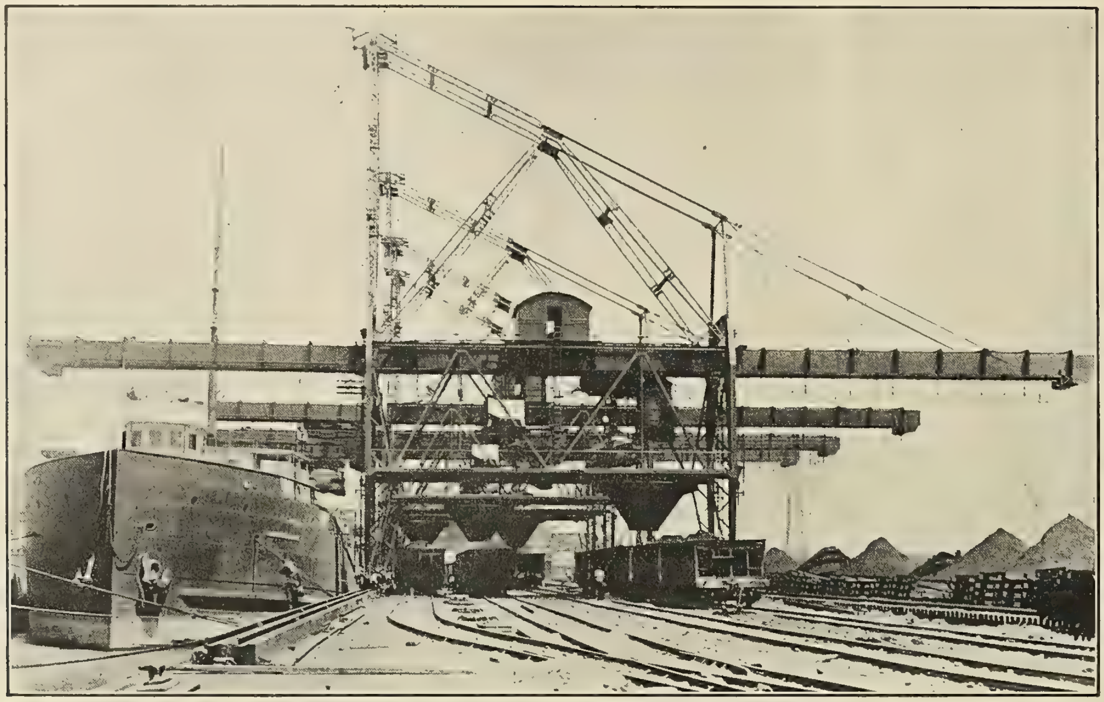
TRANSFERRING ORE DIRECT TO RAILROAD CARS.

(Copyright, 1904, Waldon Fawcett.)

ELECTRICALLY-OPERATED ORE UNLOADING MACHINES.

BY WALDON FAWCETT.

There has recently been installed on the docks of the Pittsburg and Conneaut Dock Company, at Conneaut, O.—leading terminal of the Steel Corporation fleet on the Great Lakes—an ore unloading and storage plant which is made up of new types of apparatus radically different in many important essentials from anything heretofore devised for the transference of bulk cargo from vessels to railroad cars or storage bins. The plant consists of four electrically-operated direct unloaders or "fast plants," and, working in conjunction with these, an electric bridge tramway.

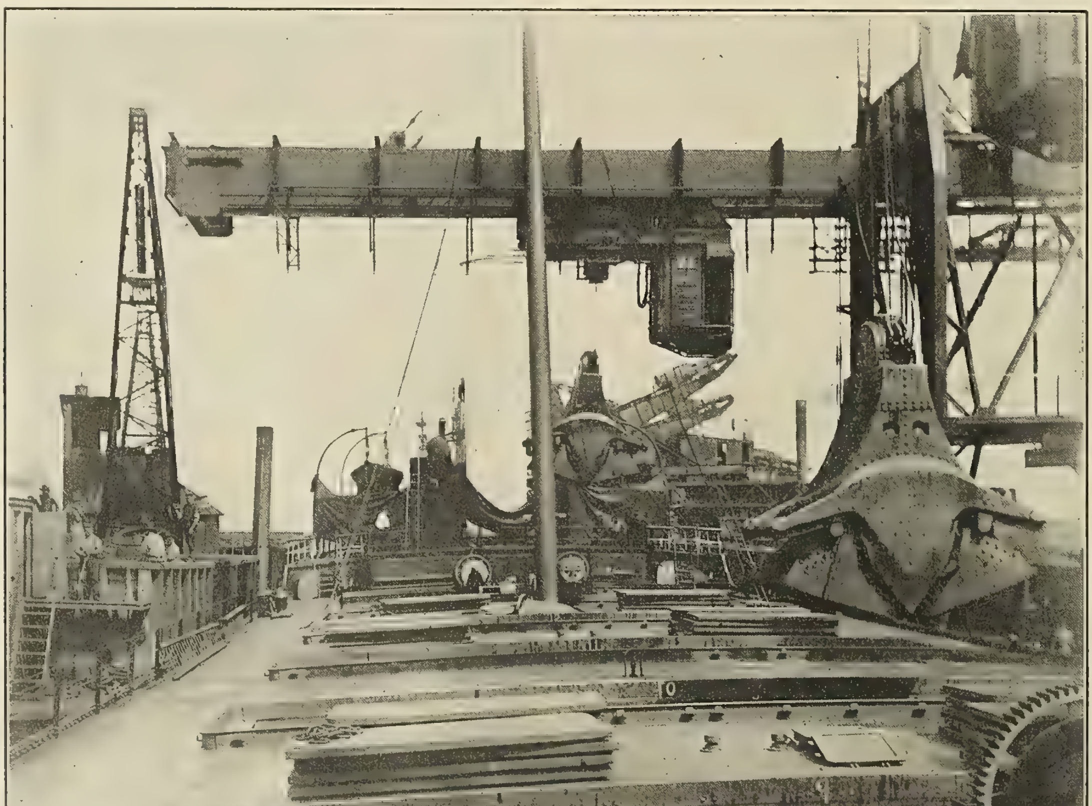


DOCK VIEW OF ELECTRIC ORE-UNLOADING MACHINES.

(Copyright, 1904, Waldon Fawcett.)

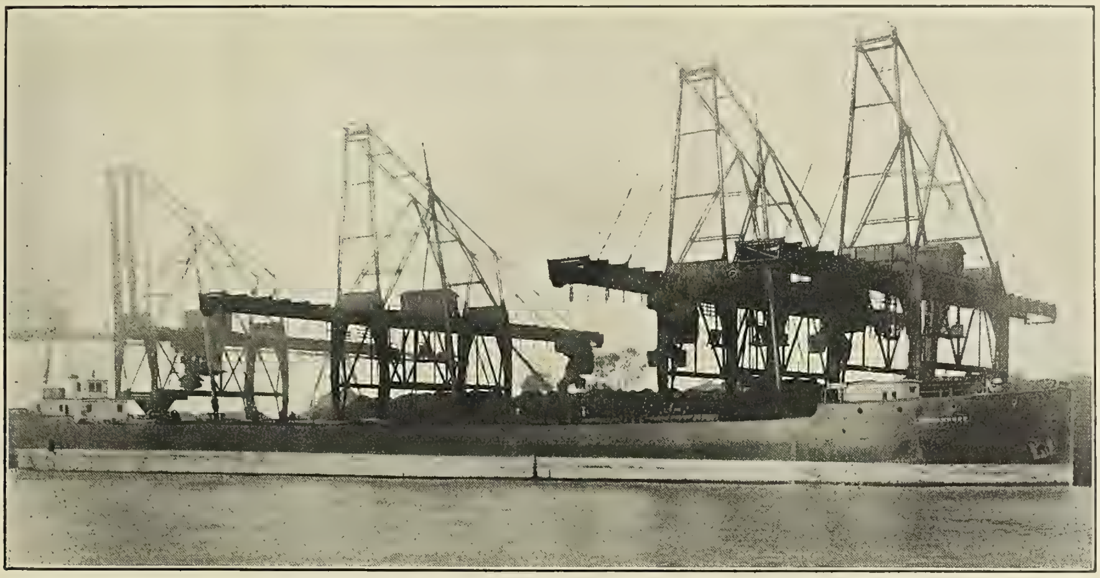
Each direct unloader consists of a portal pier spanning four railway tracks with a distance center to center of pier legs of 62 feet 10 inches, arranged with a raisable apron 59 feet 6 inches long at the front or water end and a fixed cantilever 67 feet 9 inches long at the rear end. Each direct unloader is equipped with an electric man-trolley capable of handling a fully-loaded, 5-ton, 2-rope patent ore grab-bucket at a hoisting speed of 300 feet per minute and a traveling speed of 800 to 900 feet per minute. The speed of each direct unloader along its track is from 50 to 75 feet per minute.

For the above operations each electric man-trolley is equipped with two 150-horsepower special type R (Elwell-Parker Electric Company) motors for hoisting, and one 100-horsepower motor of the same type for racking. Each direct unloader is equipped with



RAISING FULL BUCKET OUT OF SHIP'S HOLD.

(Copyright, 1904, Waldon Fawcett.)



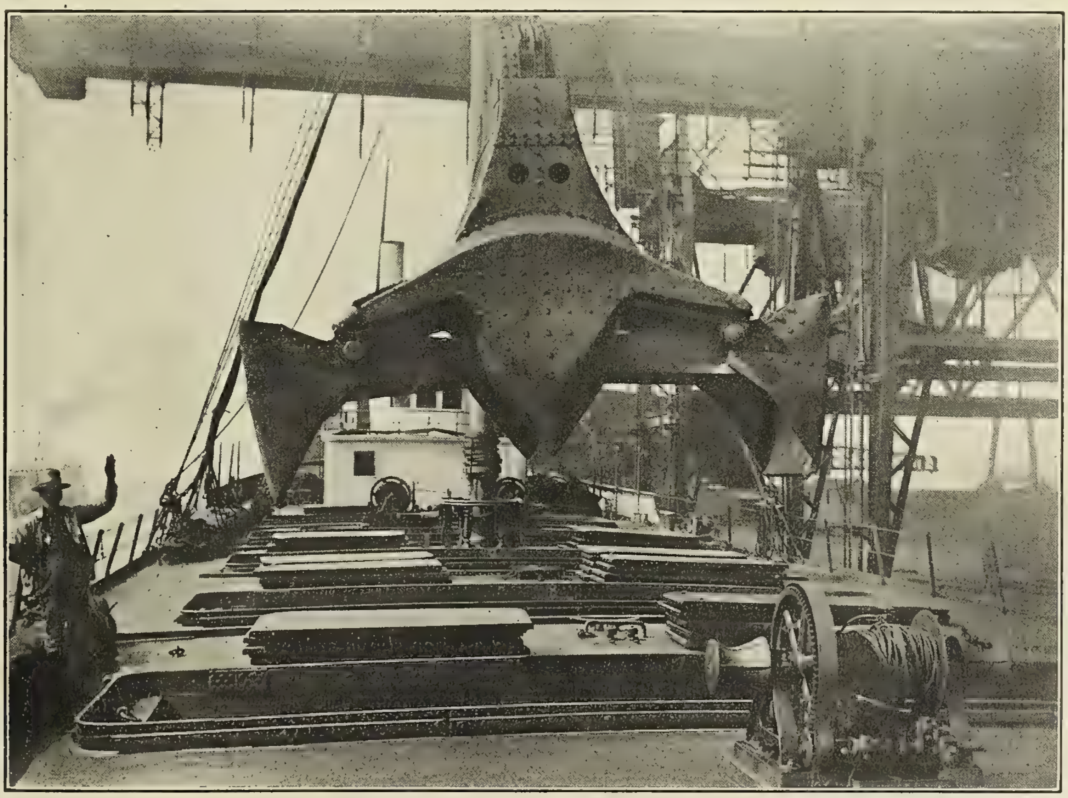
THREE MACHINES AT WORK ON STEAMER ALFRED KRUPP.

(Copyright, 1904, Waldon Fawcett.)

one 75-horsepower motor for moving the same and raising and lowering the apron. Each direct unloader requires only one man for its operation, this man riding in a cage attached to the trolley, from which position he controls the different functions of operation such as rotating, closing, opening, hoisting, and lowering of the bucket, the travel of the trolley, the travel of the crane, and the raising and lowering of the apron.

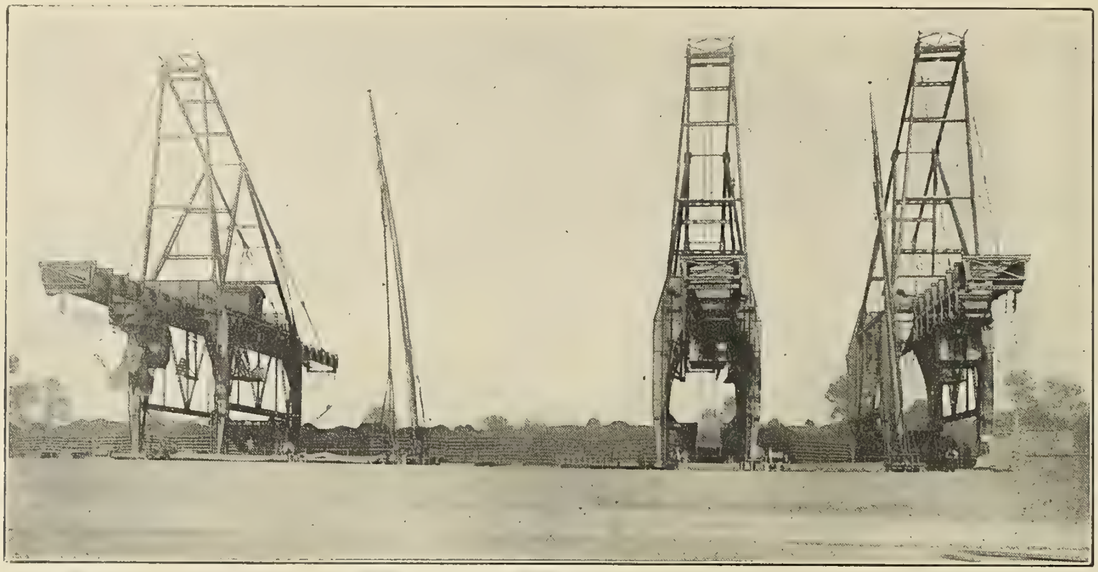
In the unloading from vessel the ore may be put into railway trucks on any of the four tracks under the pier of the crane or on the one track under the fixed cantilever arm, or into the trench under this fixed cantilever arm. For guiding the ore into the railway trucks a movable hopper is provided. The ore deposited in the trench is picked up by the electric bridge tramway and put into storage. This tramway is also capable of taking the ore from storage and putting it into the railway cars which run under the portal pier of the crane.

The electric bridge tramway consists of one span 250 feet 3 inches in length and two cantilevers, one supported at one end by a portal pier straddling two railway tracks and being 161 feet 8 inches long, while the other is supported by an A-frame shear leg and is 157 feet 9 inches long. The bridge tramway is equipped with a patent electric man-trolley capable of handling a fully loaded 7-ton, 2-rope patent ore grab-bucket at a hoisting speed of 225 feet per minute and a traveling speed along the bridge tramway of from 900 to 1,000 feet per minute. The speed of travel of the bridge tramway with full load is from 50 to 75 feet per



OPEN ORE BUCKET ABOUT TO DESCEND FOR A LOAD.

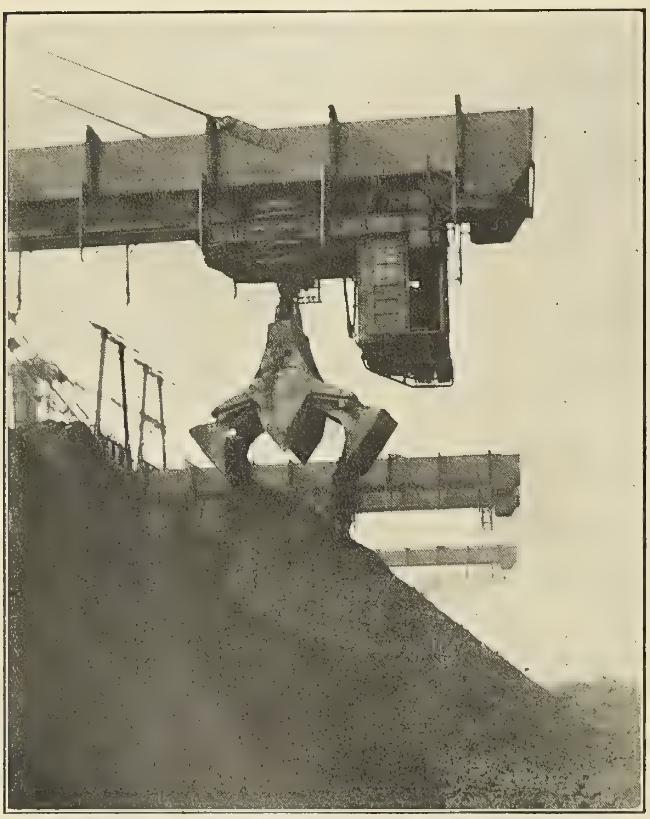
(Copyright, 1904, Waldon Fawcett.)



END VIEW OF NEW MACHINES, ON SIDE OF QUAY.
(Copyright, 1904, Waldon Fawcett.)

minute. For these operations the electric man-trolley is equipped with two 150-horsepower motors of the type above described for hoisting and two 75-horsepower motors for racking. In addition there is one 150-horsepower motor for moving the whole bridge upon its tracks.

The plant has been in operation but a comparatively short time, but has up to date handled iron ore at an average capacity per direct unloader of about 180 tons per hour. The buckets have averaged about 41 trips per hour for the entire time. A few weeks ago there was made at Conneaut a record on the four direct unloaders which surpassed any previously made by any plant anywhere in the world in so far as labor cost is concerned. This showing was made in transferring a cargo from the large steamer *Augustus B. Wolvin.* The cargo was 9,306 gross tons of very sticky ore. The total time of unloading was 15 hours and 30 minutes, or an aggregate of 62 hours on the basis of one machine. The speed of unloading was 168 net tons of ore per hour per machine. Fifteen shovelers worked for three and one-half hours in cleaning up the ore in the hold of the vessel, and this was all the labor used during the unloading except that of the four operators, one on each machine, and one oiler, who were employed during the whole time. There was a high stock pile to contend with, and the fact that some of the ore had to be put upon the dock on account of a lack of cars makes the showing all the more remarkable.



DISCHARGING ORE ON STOCK PILE.
(Copyright, 1904, Waldon Fawcett.)

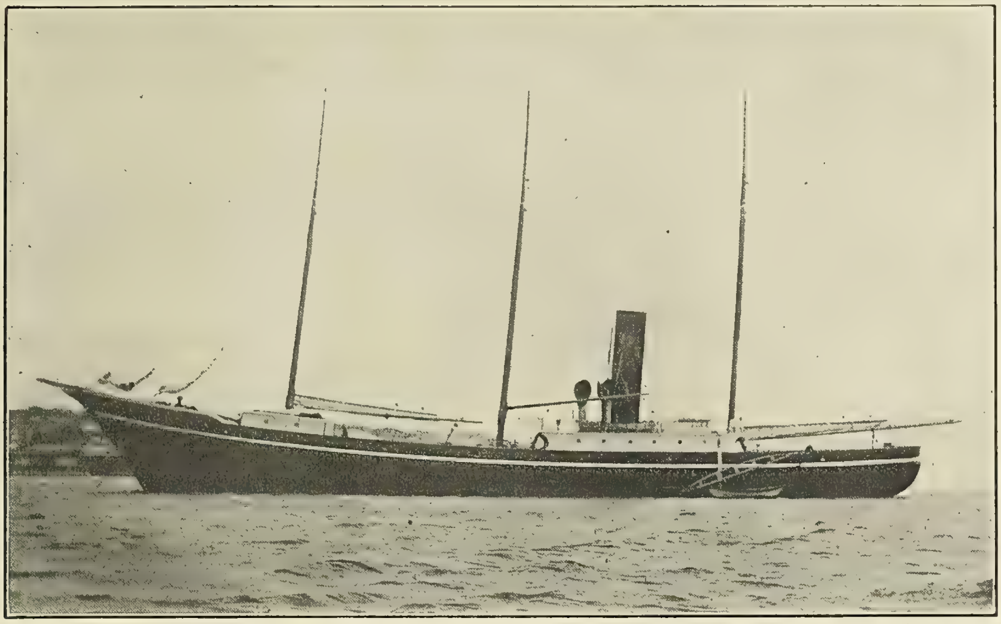
The 7-ton bridge has made an equally creditable showing. On a record of twenty-five days this apparatus handled an average of 296 tons of ore per hour, taken from the trench or pit and delivered midway on the main span of bridge. During the making of this record the bucket averaged 6.27 tons of ore per load and ran in some instances as high as 8.3 tons of ore per bucket. All this ore was handled by one man, without any helpers at either the receiving or discharging end. The above described apparatus, both direct unloaders and bridge tramway, are the invention of the engineers of the Brown Hoisting Machinery Company, of Cleveland, O.

PROPELLING MACHINERY FOR THE ARCTIC STEAMER ROOSEVELT.

Mr. Robert E. Peary's Arctic steamer *Roosevelt*, which left New York during the month of July to make an attempt to reach the North Pole, was described at some length in our May issue. Through the courtesy of the Portland Company, who constructed her engines and the Scotch boiler, which is to supply half of the steam, we are enabled to give a description of the propelling machinery as fitted to the ship.

The propelling machinery has been designed to develop about 1,000 indicated horsepower under normal conditions, with a boiler pressure of 140 pounds of steam, the engine making 100 revolutions per minute, and a speed of vessel of about 10 knots per hour when she is at her load water-line.

For the purpose for which the vessel is intended it has been deemed advisable to adhere to a moderate number of revolutions of the engine, and to design the engine strong and heavy in all its parts, the better to resist the severe shocks to which it will be subjected in forcing the ship through the ice floes, rather than a lighter and quicker-running engine. The shafting, propeller, and stern bearing have been designed with a consideration to the severe thumping which they will receive when the ship is working



THE ROOSEVELT, READY FOR SEA.
(Photo by J. O. Whittemore.)

its way through the ice, and are exceedingly heavy for the dimensions of the engine.

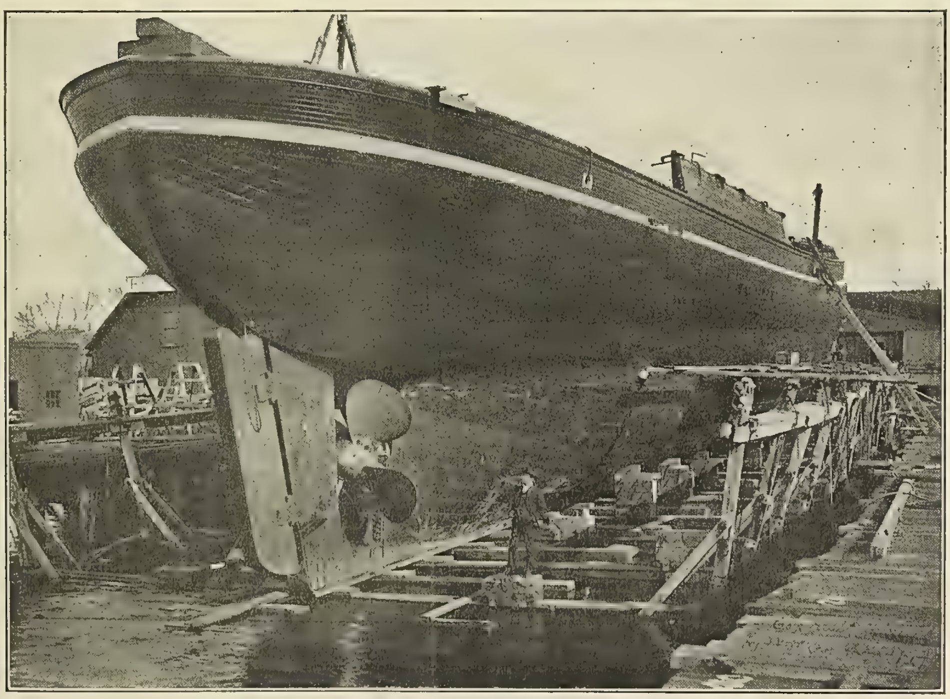
A reserve of power has been provided for in the design of the machinery by providing for an increased boiler pressure, the boiler, engine, and auxiliaries all being designed for 180 pounds steam pressure. This pressure will be resorted to only when the vessel is forcing its way through large ice floes or pushing them before it, and as the revolutions of the main engine will be less, due to decreased speed of ship, the increased boiler pressure is expected to keep the indicated horsepower up to or above the normal.

The following is a general description of the propelling machinery:

THE ENGINE.

The propelling engine is of the compound condensing type, with cylinders 24 and 52 inches in diameter, and a stroke of 30 inches; the ratio between piston areas is thus 4.69 to 1. It is of the open-frame type, with three forged steel columns on the front side and two cast-iron housings on the back side, arranged for single bar guides for the crossheads. All the valves are of the piston type, one for the high-pressure cylinder and two for the low, all these valves being arranged in the space between the cylinders, the center of cylinders being placed far enough apart for this purpose. The valves are operated by Stephenson links of the double bar type. The engine is fitted with steam reversing gear and balanced throttle valve, to be worked from below.

The pistons are of steel castings, single plate and conical in form, and fitted with two packing rings; the piston rods are of forged steel 5 3-4 inches in diameter, the low-pressure piston being

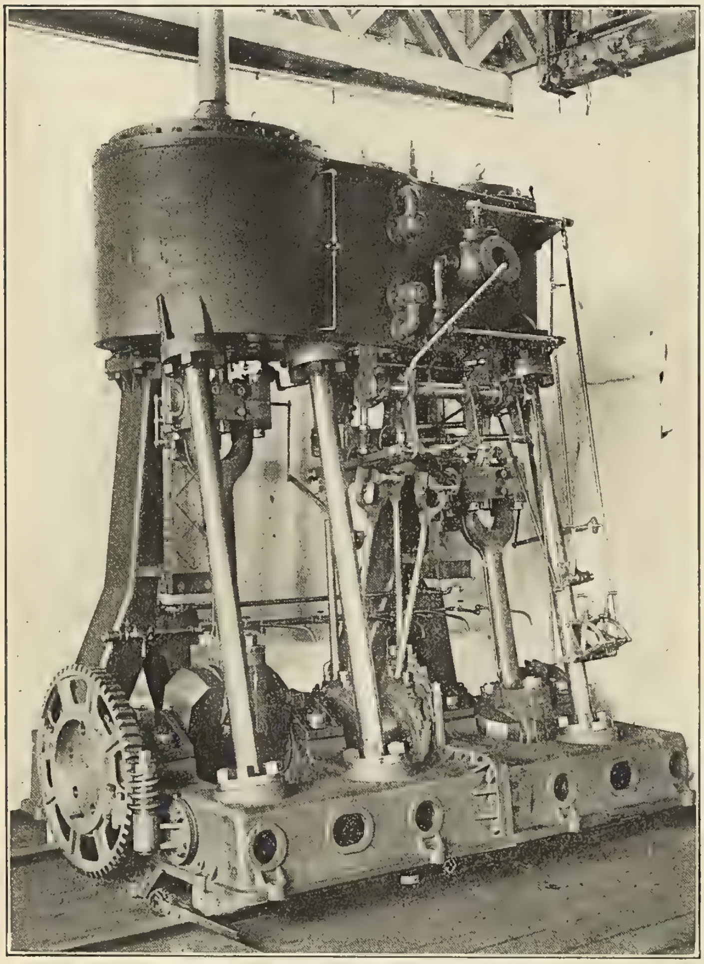


STERN VIEW, SHOWING MASSIVE RUDDER AND PROPELLER.

fitted with tail rod. The crossheads are of forged steel with two gudgeons 5 1-2 inches in diameter and 6 1-2 inches long. The crosshead shoes are steel castings fitted with bronze gibs, 13 inches wide by 20 inches long, on "ahead" surface. The slides are of cast iron cored out for water circulation. The connecting rods are 72 inches long on centers, and are of mild steel forgings; the upper end is forked and fitted with solid bronze boxes, the lower end fitted with cast steel boxes lined with babbitt metal.

The crank shaft is of mild steel forged in one piece, the cranks being at right angles to each other, the low-pressure crank leading when working in ahead gear. The crank pins are 12 inches in diameter and 12 inches long; the four main journals are 12 inches in diameter and 14 inches long.

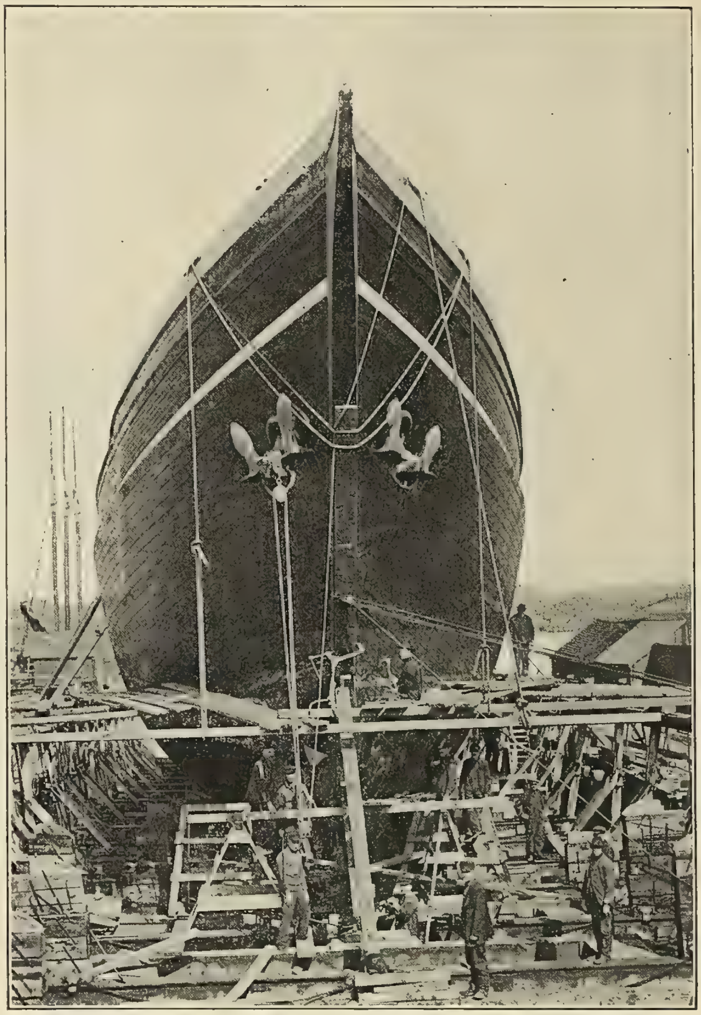
The bed plate is arranged for four main bearings. The bottom half of main bearings is semi-cylindrical in shape and of tough composition lined with babbitt metal; the top half is of steel, cast with the binder and lined with babbitt metal.



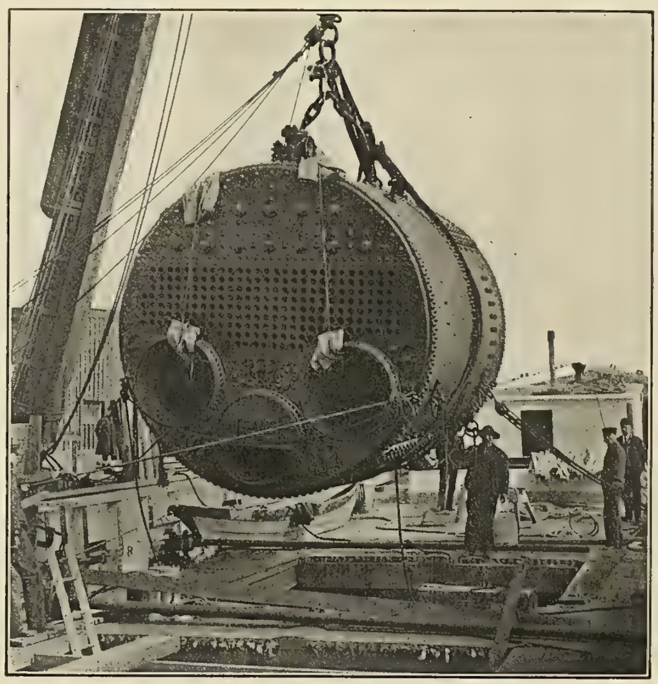
THE COMPOUND ENGINE OF THE ROOSEVELT.

The main valves work in hard cast-iron liners fitted in the steam chests. The valve travel for all valves is 7 inches, and arranged for a cut off in high-pressure cylinder of 65 percent, and in low-pressure of 70 percent of the stroke. The high-pressure piston valve is 12 1-2 inches in diameter, with a port area of 42 square inches. The two low-pressure piston valves are each 14 inches in diameter, with a port area of 124 square inches. The valve stems are of mild steel 2 inches in diameter at the stuffing box; they are guided at each end; the low-pressure stems have balance cylinders fitted at the upper end to counterbalance weight of valves, links, etc.; the lower ends of the low-pressure stems are secured to a cast-steel yoke guided in jaws secured to lower steam-chest bonnets.

The reversing engine has a cylinder 7 inches in diameter by 14 inches stroke, secured to high-pressure cylinder housing. The engine is fitted with a worm gear for hand turning; also indicator gear and lubricating arrangement for all the principal bearings.



A BOW VIEW.



LOWERING THE SCOTCH BOILER INTO PLACE.

THE SHAFTING AND PROPELLER.

The thrust shaft is of mild steel 11 1-2 inches in diameter with thrust collars 17 inches in diameter, there being seven for ahead motion and three for astern motion. The thrust block consists of two hollow cast iron shells made in halves and divided horizontally, one for ahead and one for astern motion. The shells have recesses cast in for the thrust collars, and the faces are lined with babbitt metal; both shells are mounted on one sole plate, and each is arranged for independent adjustment; the shells are fitted with water circulation, and the thrust collars run in a bath of oil. The propeller shaft is of mild steel 12 1-4 inches in diameter.

The propeller is of the sectional type with right-hand hub and blades of cast steel. It is 10 feet 6 inches in diameter and 12 feet 6 inches pitch, with a pitch ratio of 1.2, nearly. The projected area of all four blades is 56 square feet, this giving 0.648 as the disk ratio, a very large figure, due to the necessity of having great blade areas to overcome the heavy resistances to be met. The propeller is fitted with four blades, but it is intended to use two only when the vessel encounters the ice.

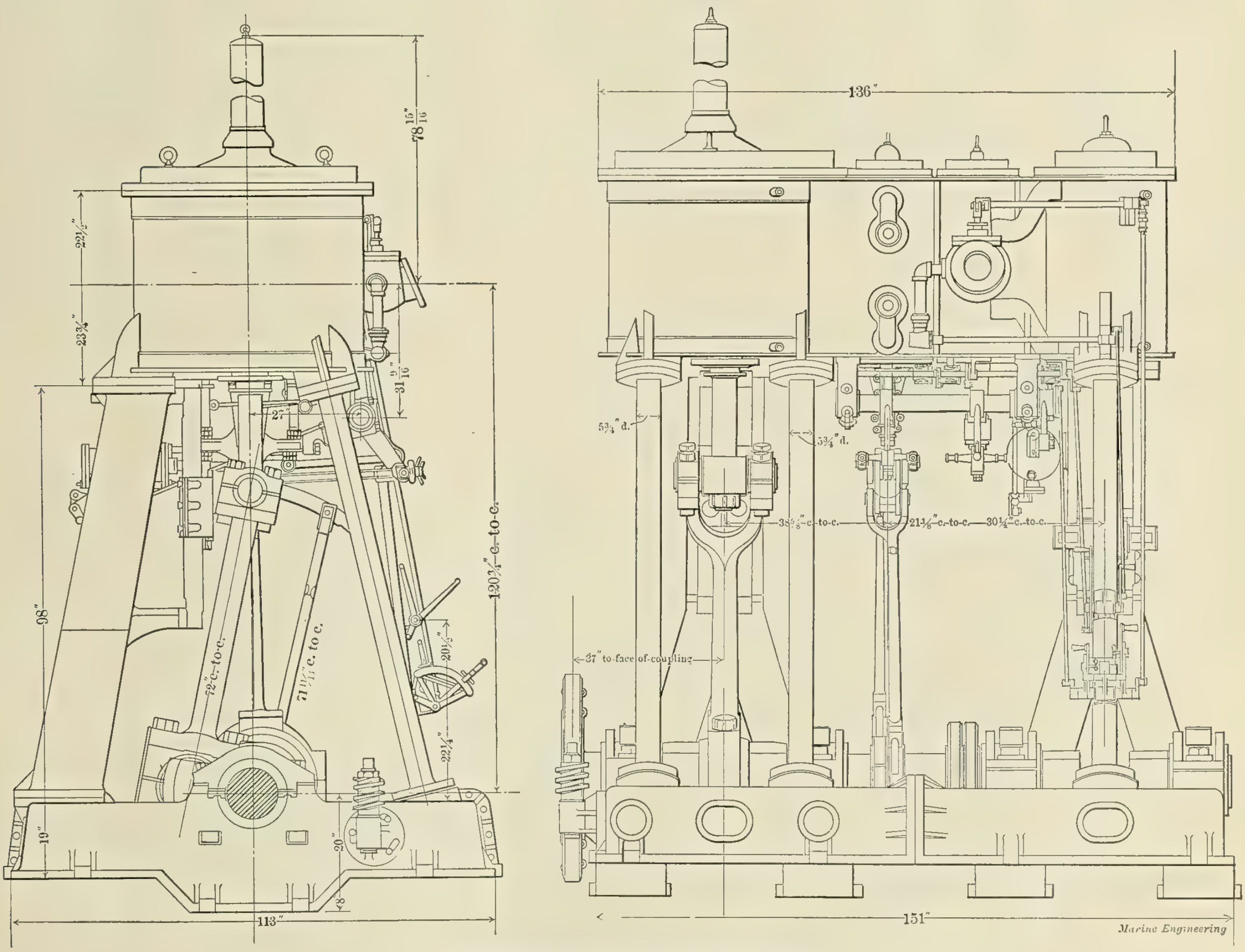
The shaft log is lined with lead 1-4 inch thick and is fitted with inboard stuffing box of cast iron lined with composition. The stern bearing is a steel casting and made very heavy; it is lined with staves of lignum-vitæ, giving a bearing 40 inches long.

THE CONDENSER AND PUMPS.

The surface condenser is circular in form and is independent of the engine framing, being mounted directly over the air pump, the latter forming foundation for one end of the condenser. The shell is of steel plate 7-16 inch thick, with water bonnets of cast iron; the shell is 48 inches in diameter and 8 feet long. There are 1,200 3-4-inch condenser tubes set in composition tube sheets with brass screw glands. The condenser contains 1,800 square feet of cooling surface.

The pumping outfit consists of one 8-inch centrifugal circulating pump, one horizontal simplex vacuum pump, one horizontal duplex main feed pump, and one horizontal duplex auxiliary pump.

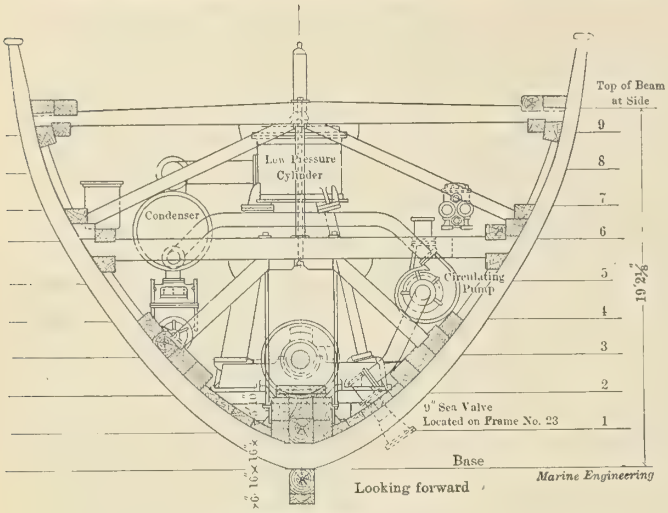
The circulating pump is of the Morris Machine Company's standard pattern, and is directly connected to a 7 by 7-inch engine. The suction of this pump is connected to the Kingston valve with an 8-inch copper pipe; it also has a 5-inch branch to the bilge, fitted with a non-return valve. The discharge to condenser, and from condenser overboard, is through an 8-inch copper pipe.



END AND SIDE ELEVATION OF THE MAIN ENGINE.

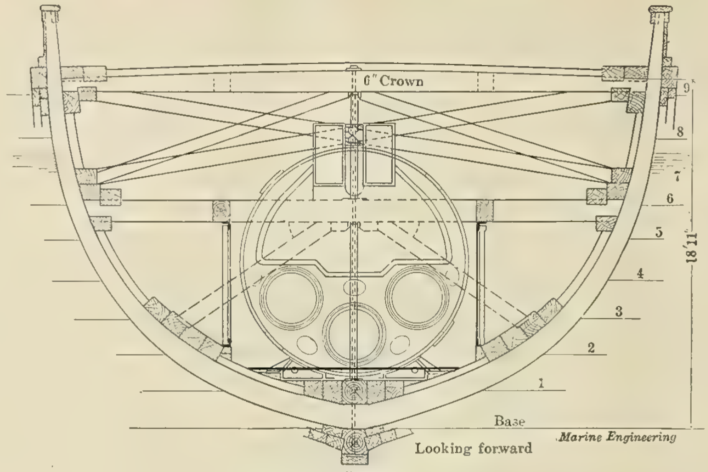
The vacuum pump and two feed pumps are furnished by the Warren Steam Pump Company, of Warren, Mass. The vacuum pump has a steam cylinder 10 inches in diameter, a vacuum cylinder 18 inches in diameter, and a stroke of 18 inches; it is located directly below the condenser, the water end forming a support for one end of the condenser. The air-pump suction is connected to the condenser with a 5-inch copper pipe and discharges to filter tank through a 4-inch copper pipe.

The main feed pump has steam cylinder 8 inches in diameter, with water cylinders 5 inches in diameter and a stroke of 12 inches; the suction of this pump is connected to the filter box and fresh-water tanks only, and discharges to the main feed pipe only. The auxiliary feed pump is of the same dimensions as the main feed pump, the suction being connected to the fresh-water



FRAME NO. 24

SECTION IN WAY OF ENGINE.



SECTION AT FRAME NO. 42
BRACING IN BROKEN LINES ON NO. 41

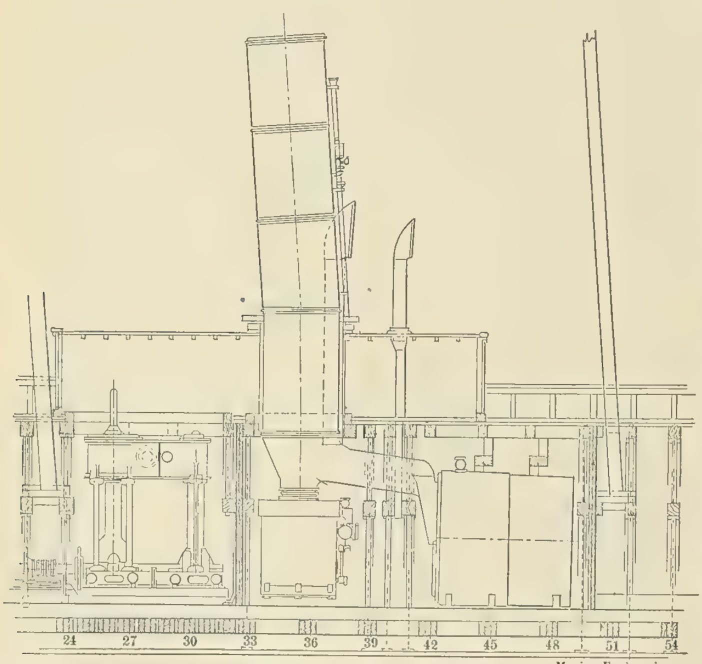
SECTION IN WAY OF SCOTCH BOILER.

tank, filter tank, 6-inch Kingston valve and bilge, with a discharge to the auxiliary feed-pipe line, also to main deck through 2-inch hose-hydrant valves, and a discharge overboard; there is also a 5-inch discharge pipe to the condenser, to be used if the circulator becomes disabled.

THE BOILERS.

Steam will be supplied by one single-ended, three-furnace Scotch boiler and two Almy water-tube boilers. The Scotch boiler is designed for a pressure of 185 pounds, and the safety valves of the water-tube boilers are loaded to this pressure. It is intended that the vessel will steam under 140 pounds working pressure under normal conditions, as explained above.

The Scotch boiler is 12 feet mean diameter and 11 feet 8 inches long outside of heads, and contains three 38-inch Morison suspension furnaces 9 feet long, and 217 3-inch tubes 9 feet long; 153 of these tubes are of ordinary thickness (No. 12) and 28 are of No. 10 gauge, the remainder, 36, are stay tubes tapped into the tube sheets at each end, and fitted with lock nuts. The stay tubes are arranged in the bounding rows, and the extra gauge tubes are arranged in every other row horizontally and vertically.



LONGITUDINAL SECTION THROUGH MACHINERY SPACES.

There are two Class E Almy water-tube boilers, 79 15-32 inches wide, 82 5-16 inches long, and 113 7-8 inches high from bottom of ash pan to top of hood.

The heating surface and grate area are as follows:

	Heating surface, sq. ft.	Grate area, sq. ft.	Ratio.
One Scotch boiler,	1,772	54	32.9
Two water-tube boilers,	2,572	60	42.9
Total,	4,344	114	38.1

The boilers are arranged in a watertight compartment, the Scotch boiler forward and the two water-tube boilers aft, the latter being arranged side by side and connecting into one smoke box. There is one smoke stack for all three boilers. It is made oval in plan, 7 feet in a fore-and-aft direction, and 3 feet athwartship, and is located directly over the water-tube boiler, with a flue connecting with uptake on Scotch boilers.

The main steam pipes and branches are all of copper, and the auxiliary steam pipe is of copper, but the branches are of extra thick wrought iron pipe with steel fittings. The boilers and steam pipes are covered with non-conducting material applied by the C. W. Trainer Manufacturing Company, Boston, Mass.

GENERAL.

The boilers, engine, steam piping, and all the auxiliaries are designed strong enough in all parts for the maximum steam pressure of 180 pounds, and they comply in all respects with the rules and regulations of the Supervising Inspector of steam vessels of the United States. The coal bunkers extend the length of the boiler space in the vessel; each side of the boiler and fire room they have a capacity of about 120 tons.

The fresh-water tanks are located in the after part of the vessel, being built to fit in between the "'tween" deck beams, and they fit the shape of the vessel where located. They have a capacity of about 2,400 gallons. In connection with the fresh-water tanks there will be a large open tank on deck, fitted with steam pipes for the purpose of melting fresh water ice.

The minimum of space has been allotted to the machinery, as it is necessary to use all the space obtainable for coal and other supplies. Every cubic foot in the machinery space has been utilized with machinery, lockers, etc., with just enough clearance to get at the different parts. The weight of the entire machinery, ready for sea, excluding coal and water in tank, is about 137 tons.

For this description, and the illustrations accompanying same, we are indebted to the Portland Company, of Portland, Me., the builders of the engines and of the Scotch boiler.

THE FIRE-BOAT GEORGE H. WILLIAMS, OF PORTLAND, OREGON.

This new fire-boat has been in service nearly a year, and has proved herself a complete success. We present herewith a general description and a few illustrations which may be of interest to our readers.

It was the original intention of the Fire Department and the designer to have the hull built of steel, but bids received exceeded the appropriation of $62,000, and a wooden boat had to be built. In order to reach certain parts of the harbor, the draft had to be limited to less than six feet, and for this reason the model had to be full and twin screws had to be chosen. The hull is built very staunchly of Oregon oak and yellow fir. The outside is double-planked diagonally next to the frames and fore-and-aft outside.

As no heavy weather has to be met the boat is very low above the water and has not much sheer. The hull is 115 feet over all, 102 feet between perpendiculars, 25 feet molded breadth, and 8 1-2 feet molded depth. The displacement is 240 tons ready for duty. The hull is divided into four compartments by bulkheads. The first compartment contains chain lockers, the second hose reel, and stores, the next the two boilers and fire room, the fourth pumps, propelling machinery and workshop.

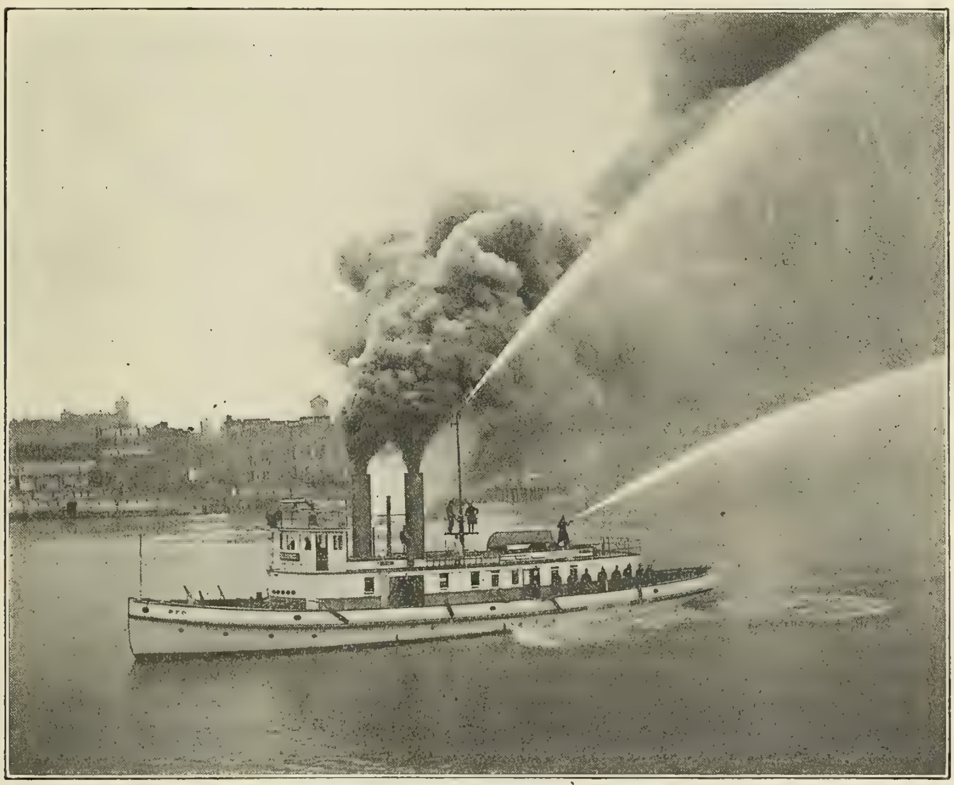
The deck-house has a circular front and extends aft over 70 feet and is 14 feet wide. It is subdivided by bulkheads as shown in plan, containing in first compartment valves and nozzles with ten 3 1-2-inch outlets around the circular front; in next, the boilers and pipings; next, the engine room; aft of this, both toilet and lamp room; and then two hose reels. The pilot-house is placed on top of the deck-house and carries on top a 6-inch Monitor nozzle and an 18-inch searchlight. A continuous trunk skylight runs from the pilot-house aft. The upper decks are sheathed with heavy zinc for protection against sparks.

The vessel is provided with four pairs of strong oak mooring bitts, a pair of tow posts, iron chocks, a capstan windlass, metal lifeboat with skids, etc.

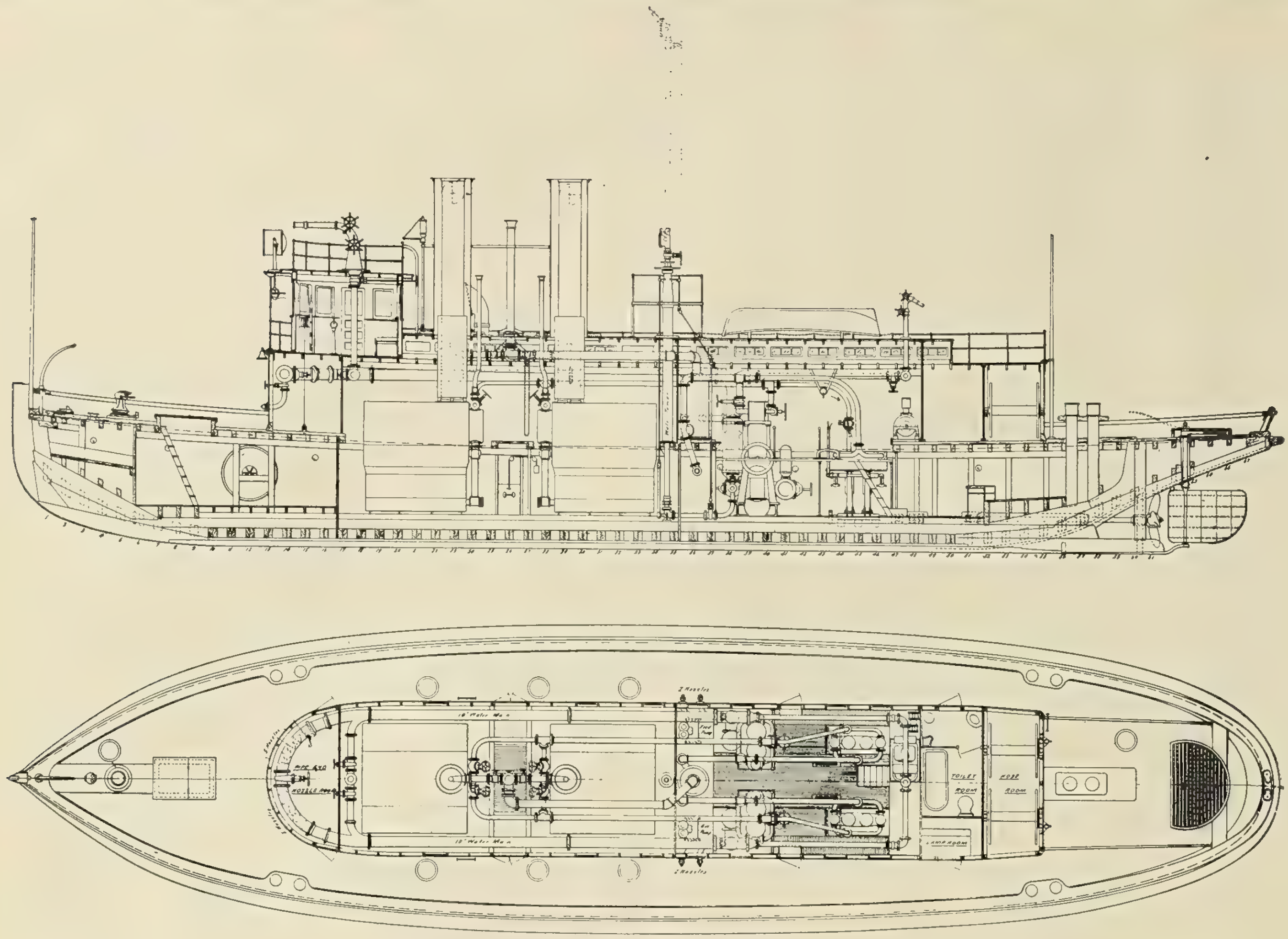
To insure good steering the rudder is made exceptionally large, and the deadwood between skeg and hull is left open. The boat will double on her track at full speed in thirty seconds, and within a radius of fifty feet.

The propelling machinery consists of two pairs of high-pressure engines, having cylinders with 10-inch bore and 14-inch stroke, turning with 160 pounds at 250 revolutions per minute, and operating propellers with a diameter of five feet. The indicated horsepower developed on trial was 434, driving the vessel 12 miles an hour. As the water of the Willamette is fresh, condensing apparatus was not required.

There are installed two of the latest American Fire Engine Company's fire pumps, each having two steam cylinders 17 inches in diameter and water cylinders 10 inches in diameter, with a common stroke of 11 inches. The pumps are of the direct-connected, fly-wheel, vertical type, and at 240 revolutions will discharge 6,748 gallons of water per minute. In order to maintain this high speed safely and without undue vibrations, the pumps are seated on a pair of 12-inch I-beams resting on four continuous keelsons, thus distributing the vibrations over the whole bottom. A 16-inch suction main connects with two 24-inch sea-openings, as shown on cross section. By closing sea-valves and opening valve to bilge the vessel may be kept clear in case of accident. Opening is also provided in suction pipe to utilize pumps for wrecking purposes. Each pump has a 12-inch discharge dividing under cabin deck into one 10-inch and one 5-inch branch. The 10-inch branches from each pump run forward and are connected together by a circular manifold from which ten 3 1-2-inch nozzle branches are taken, couplings and valve-wheels projecting through front of house. The couplings are made especially to take the 3 1-2-inch, 3-inch, and 2 1-2-inch hose connections. From the vertical 12-inch discharge pipe branches are taken to two 3 1-2-inch hose connections, each side of house, so that in all fourteen of these connections are provided. The discharge pipes are made of semi-steel with male and female flanges, and the system was tested under 500 pounds cold-water pressure. To relieve sudden



THE FIREBOAT GEORGE H. WILLIAMS AT WORK.



INBOARD PROFILE AND DECK PLAN OF GEORGE H. WILLIAMS.

shocks and expansions, copper sections were used between circular manifold and main pipes, which are branched again aft of nozzle room to supply the 6-inch turret nozzle on top of pilot house. Valves are so arranged that either pump can supply the whole system or only half. The 5-inch branches leading aft from 12-inch vertical discharge pipe supply water to a 2 1-2-inch deck turret.

Steam is generated by two Taylor water-tube boilers of latest design. They have a total heating surface of 4,500 square feet and a grate surface of 96 square feet. They have 36-inch steam drums tested for a working pressure of 250 pounds. Stop valves and steam pipes are in duplicate so that one or both boilers may be used on either port or starboard pump or engine.

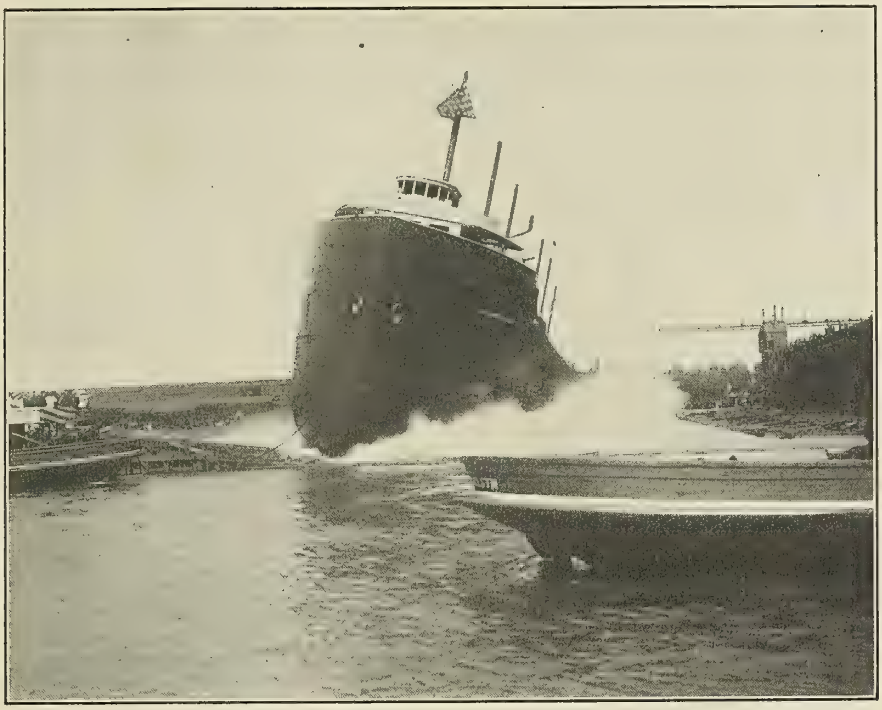
The boilers have independent smokestacks, which not only improves their efficiency but also insures a cooler fire-room. The exhaust from machinery, after passing through heater located in engine-room, is used for draft in stack, or may, by a simple system of butterfly valves, be exhausted directly into the atmosphere.

The boilers have exceeded in their performance all expectations. On trial, pumps and propelling engines were run at full speed, and dampers on boilers had to be kept closed frequently to stop the blowing off. While boat is on duty steam is kept in both boilers at 150 pounds, and records kept show that 1,500 pounds of ordinary Pacific Coast coal is used every 24 hours. The great advantage of these boilers over the Scotch type lies in the small space occupied, their capacity, economy, light weight, quick steaming and high pressure. On test 150 pounds of steam was raised in a cold boiler in 6 1-2 minutes. The steam after leaving boiler is reduced to 150 pounds for the pumps.

The auxiliary machinery consists of two Admiralty type Worthington pumps of 80 gallons per minute capacity, located against the forward bulkhead in engine room, within easy reach of the engineer. The main feed-pump discharges through a copper-coil heater located between the two pumps. This heater has an exhaust connection to a siphon condenser discharging overboard to relieve the pressure in heater due to the choking of exhaust in smokestacks.

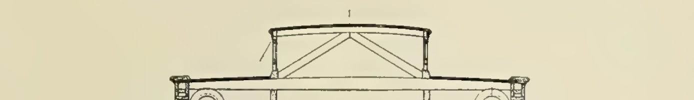
The boat is equipped with a 7-Kw. direct-connected General Electric generating set, and lighted with electricity throughout. The wiring in boiler-room is in metallic conduits. The latest improved steam-tight fixtures, switches, and cut-out boxes have been used. The electric wiring is connected with the shore, releasing automatically when the vessel leaves the dock.

A novel feature of the boat is the water-tower, invented by the designer. This tower represents the first one ever installed on a fire-boat and has proven itself a great success. It is located forward of the bulkhead between engine and boiler-room and occupies very little space. In principle it consists of a 4-inch brass standpipe supported at keelson in an elbow connected with the discharge ends of each pump, the inlet to pipe being regulated by a gate valve having its stem extended to a platform on top of deckhouse. Over the brass standpipe telescopes a 5-inch extra heavy turned steel pipe, having at its bottom end a stuffing box, and carrying on top a gate valve and flexible nozzle, which can be raised or lowered by a rope purchase. The valve is fitted with a chain wheel and chain and can be operated when tower is at any height. The 5-inch pipe is guided by the standpipe on the inside and on the outside by the stand above platform, and supported by a 10-inch pipe on the main deck and braced to the house. A split-sleeve is supported in this stand and when the pipe is raised to the desired elevation this sleeve is tightly clamped to pipe. The sleeve is surrounded by ball bearings so designed that vertical and lateral strains cause no undue friction, and at bottom of stand another ball bearing takes care of the lateral and vertical pressure when



SIDE LAUNCH OF WILLIAM E. COREY.

the pipe is at its extreme height. To the sleeve is keyed a large brass hand-wheel by which the tower or extended pipe may be swung around its axis. A relief valve is connected to the bottom elbow and its stem is also extended to the platform, so that by opening same the tower can be lowered after the pressure has been shut off by a simple opening of this relief valve. On test the tower threw a 2 1-4-inch stream a distance of 450 feet from



SECTION IN WAY OF ENGINE ROOM.

an elevation of 45 feet above the water-line. It is operated by one man.

The equipment of the boat includes three hose reels, working in ball bearings, each capable of carrying one thousand feet of 3 1-2-inch hose with couplings. One reel, as above mentioned, is below deck forward, and the other two in after end of deck-house. The hatch and door openings are fitted with rollers to guard against the hose dragging and cutting. For working hose on deck short lengths are provided and special crutches set in sockets in rail are furnished.

The fire-boat was designed by Fred. A. Ballin, of Portland, and built by the Willamette Iron and Steel Company of Portland, who sublet the hull to the Portland Shipbuilding Company.

The Launch of the William E. Corey.

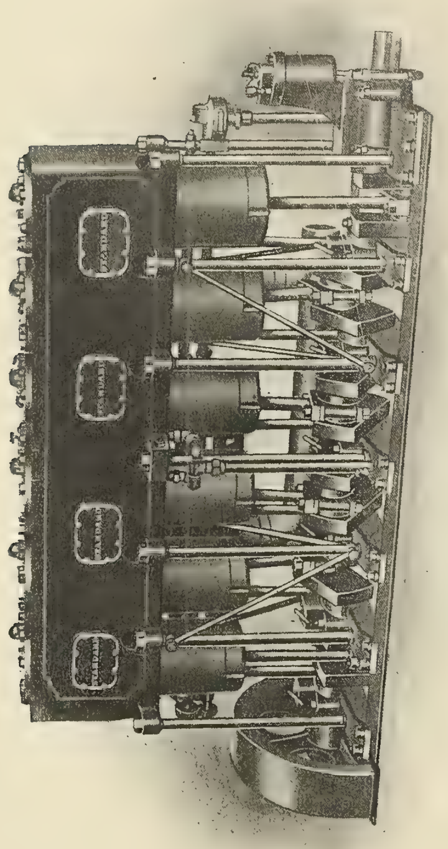
This new sister ship of the *Elbert H. Gary*, the *George W. Perkins*, and the *Henry C. Frick*, was launched June 24 from the South Chicago yard of the American Shipbuilding Company. We give an illustration of this launch, which it will be noted was from the side.

The four ships above mentioned are the largest vessels on the Lakes, having a length over all of 569 feet, a keel length of 549 feet, a beam of 56 feet, and a depth of 31 feet. The tonnage is 4,988 net and 6,331 gross. The estimated cargo-carrying capacity is 11,000 tons. With engines of 1,800 horsepower it is expected that a speed of about twelve miles will be maintained. In order to insure great carrying capacity, the hopper principle adopted in the *Augustus B. Wolvin* last year has been developed to an even greater extent than was the case on the prototype, and it is expected that these four ships will prove to be in many ways the most economical to operate on the Great Lakes.

The Launch Gregory.

Ninety feet long, with a 12-foot beam and 4-foot draft, this launch is propelled by two 300-horsepower, six-cylinder, reversible, "Standard" gasoline engines, and is lighted by a "Standard" direct-connected electric-light plant of 4 horsepower. The boat contains forward three tanks, with a capacity of 1,500 gallons; she also contains four tanks aft, with a capacity of 2,500 gallons, making a total of 4,000 gallons, which equals in weight, approximately, 13 tons. With 6 tons of fuel aboard, the total weight of the boat was designed for 30 tons displacement. The accompanying chart illustrates the fuel consumption trials, which were made to determine the feasibility of crossing the ocean on its own tank capacity.

It will be noticed that when driving under one engine with the other propeller uncoupled, so as to allow it to rotate freely, the boat can sail 5,050 miles, when running at the rate of 7.77 miles per hour. When running at the rate of 10.63 miles per hour she can sail 4,600 miles. When running at the rate of 13.16 miles per hour she can sail for 3,360 miles. It will be noticed in comparing these figures with the work of the government torpedo boats that sailed to Manila, that the fuel con-



SIX-CYLINDER ENGINE OF THE GREGORY.

sumption is far more economical than with coal. The smallest government boat carried some 190 tons of coal when leaving San Juan, and steaming at the rate of 10 1-2 miles per hour they found it necessary, or considered it so, to coal at sea before arriving at the Azores, a distance of only 1,700 miles. To compare these figures with the *Gregory*, a boat much smaller in every way, which carries only 13 tons of fuel, but is able to operate more than 2 1-2 times as far without resorting to deck loads and auxiliary fuel-storage compartments, certainly indicates the great advantage that the internal combustion engine operating on liquid fuel has over steam on long cruises.

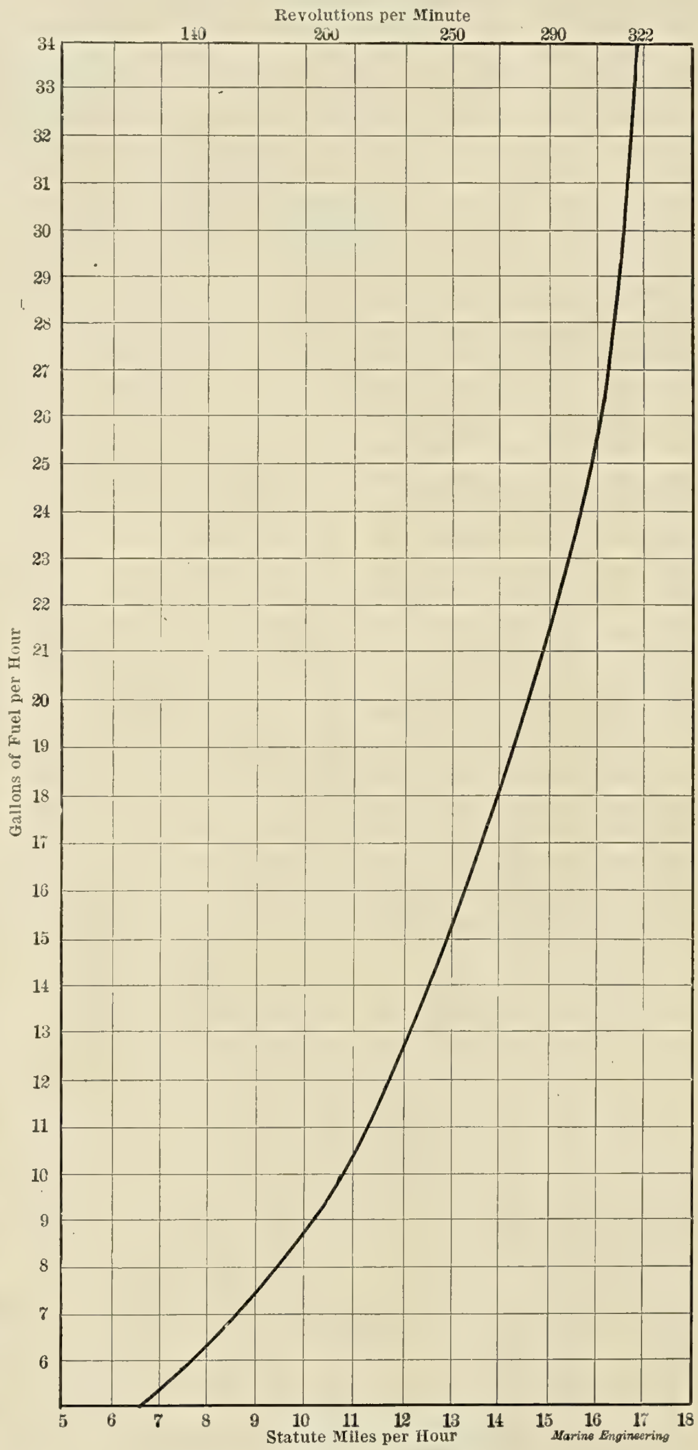
The maximum speed of the boat has not as yet been exactly determined; a speed of 23 miles having been made while the boat was loaded beyond her regular trim. Under these conditions the fuel consumption is some sixty odd gallons per hour. This would drive the boat at full speed nearly 1,400 miles, which is again considerably more than high-speed boats of the torpedo type could ever accomplish.

TABLE OF PERFORMANCE.*

R.P.M.	Speed, Knots.	Speed, Miles.	Fuel per hour, gallons.	Radius of action, Days.	Radius of action, Miles.
145	6.75	7.77	6.12	27.3	5,050
202	9.23	10.63	9.6	17.4	4,605
252	11.43	13.16	15.65	10.7	3,360
322	14.50	16.70	32.7	5.1	2,040

*Port engine running. Starboard propeller uncoupled.

THE GREGORY.



FUEL CONSUMPTION CHART OF GREGORY.

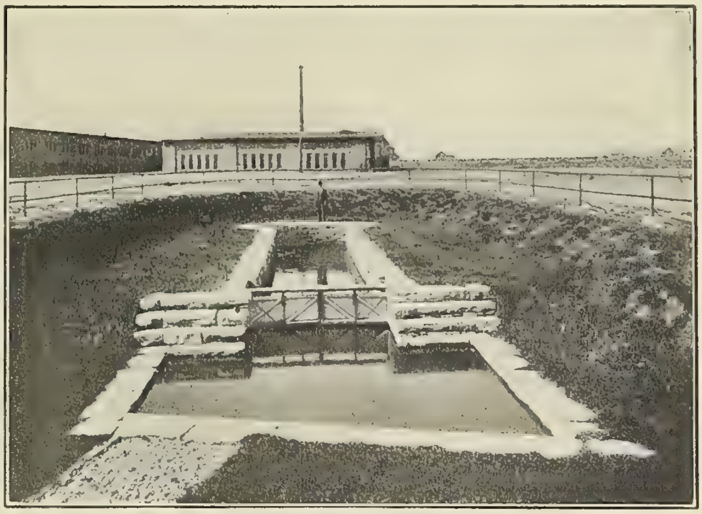
The *Gregory* had a very difficult passage across the Atlantic, having left New York originally January 5 for Bermuda and being driven back by a high storm. She left again February 8 and reached Bermuda February 16. On March 1 the voyage was resumed, the boat heading for the Azores. Another storm being encountered, however, she again had to put back to port with one cylinder broken. She finally left Bermuda March 19, and reached the Azores April 4, after having passed through another heavy storm. The provision of gasoline was now exhausted and it was necessary to await a new supply from Lisbon, which required a stay of more than a month. On May 10 the Azores were left and Algiers reached the 17th. Since that time the motor boat has passed through the Dardanelles and arrived at Sebastopol, where she was turned over to the Russian government for use as a torpedo despatch boat.

THE SEMI-CENTENNIAL OF THE SOO CANAL.

The first lock ever constructed on the American continent was built by the Hudson Bay Company at the falls of the Sault Ste. Marie in the year 1797-98. It had a length of 38 feet, a width of 8 feet 9 inches, a depth of 9 feet, and a draft of 2 feet 6 inches. It was destroyed by an American force in 1814, but has been repaired, and may be seen at the Soo, in the yards of the Lake Superior Power Company. It will be noted from the figures given that this lock with its abutments complete could have been placed athwartship in one of the large steamers now running through the present locks of the Sault Ste. Marie canal, and the space it occupied would scarcely be missed.

The present canal, however, was first built and put in operation early in the second half of the nineteenth century, having been opened June 18, 1855. It was built under the auspices of the state of Michigan, and cost in round numbers about $1,000,000, while the cost for maintenance increased from $4,400 in the first year to about $9,000 in 1880. Tolls were charged of four cents per ton up to 1877, and then three cents per ton until 1881; but when on June 9, 1881, the entire canal property was transferred to the United States government, tolls were abolished and the canal and locks were made free for vessels of all classes.

In the meanwhile a new lock had been under construction, and this, the Weitzel lock, was opened September 1, 1881. It is 515 feet long and 80 feet wide, with a width at the gates of 60 feet,



THE FIRST LOCK IN AMERICA.

(Photo by A. E. Young.)

and cost approximately $2,180,000. The present largest lock is known as the Poe lock, and was opened August 3, 1896. This is on the site of the original lock of 1855. Built at a cost of about $3,000,000, this lock has a length of 800 feet and a width of 100.

The original locks of 1855 were the largest in existence. They were two in number, and placed in tandem, each being 350 feet long, 70 feet wide, 11 1-2 feet depth of water, and a lift of about 9 feet. The depth of water in the Weitzel lock is 17 feet, with 16 feet over the sill; while that in the Poe lock is 21 feet.

The original canal had a length of slightly more than one mile, a width at the bottom of 64 feet, and at the surface of the water 100 feet, and was 13 feet deep. While the Weitzel lock was under construction the mean width of the canal was increased to 160 feet and the depth to 16 feet. Since 1892 the American canal has been deepened to 25 feet and somewhat extended in length, so that it is now 1.6 miles from end to end. The width varies from 108 feet at the canal gate to 270 feet at the basin above the locks, 500 feet at the upper entrance, and 1,000 feet at the lower entrance.

THE WEITZEL (AT LEFT) AND POE (AT RIGHT) LOCKS, LOOKING TOWARD LAKE SUPERIOR.

(Copyright, 1905, Detroit Photographic Company.)

STEAMER SONOMA LEAVING WEITZEL LOCK.

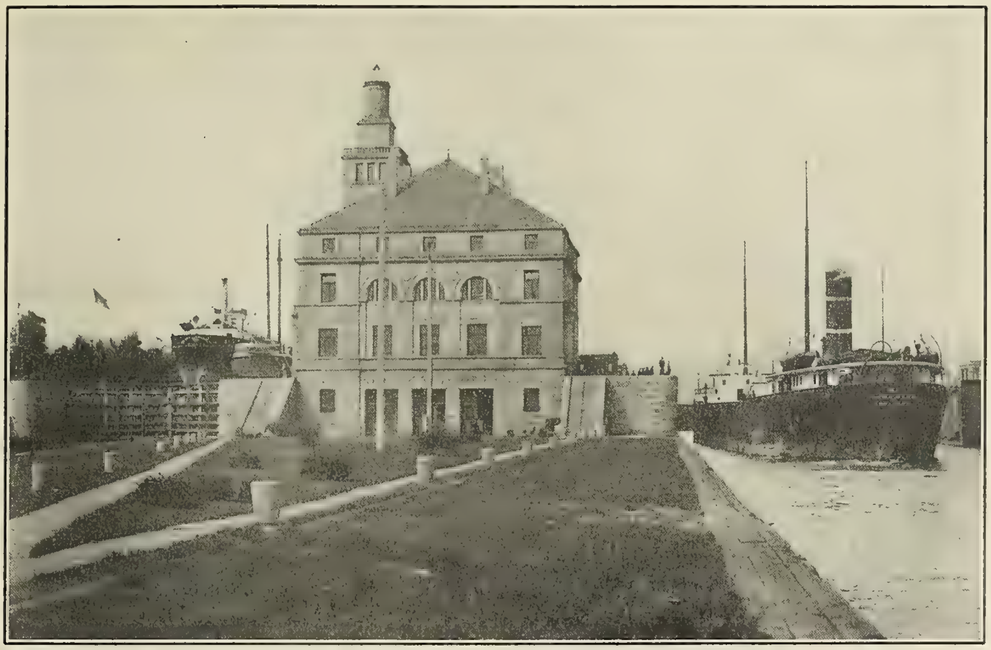
(Copyright, 1905, Detroit Photographic Company.)

The Poe lock is so admirably fitted for its duty that it can be filled or emptied in about seven minutes, and the gates opened or closed in two minutes. It is on record that a single boat 350 feet in length has made a passage through the lock in eleven minutes. The average time last season, however, was about twenty-nine minutes, due largely to the slow movement of boats in entering and leaving. The average time through the Canadian lock, which is 1,000 feet long, 80 feet wide, and with 22 feet of water on the sills, was 16 minutes.

As an indication of the immense traffic through these canals we will quote figures for the season of 1904, which was, by the way, a considerably smaller one than the preceding year. The number of steamers passing through the canal was 12,188; sailing vessels 2,994, and unrigged vessels 938; making a total of 16,120, or 72

CAPACITY OF POE LOCK SHOWN BY FOUR STEAMERS IN IT AT ONCE.

(Photo by A. E. Young.)



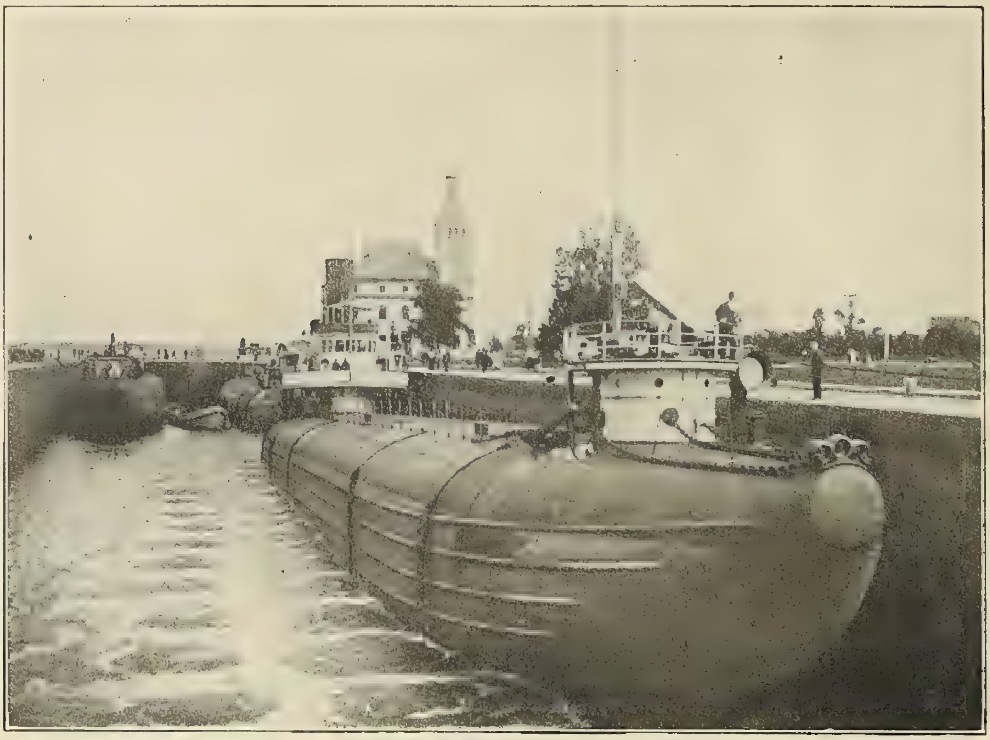
THE ADMINISTRATION BUILDING AND LOCKS.
(Copyright, 1905, Detroit Photographic Company.)

ships per day during the season of 223 days. The number of lockages was 10,315, or 46 per day.

The net tonnage register of the ships passing through was 24,364,138, or 109,000 per day and 1,516 per ship. The quantity of freight carried through in that time was 31,546,106 tons, or 141,000 per day and 1,961 per ship. Of this freight, iron ore accounted for 19,635,797 tons, or 88,000 per day, and coal for 6,454,869 tons, or 29,000 per day. The largest traffic for a single day was September 6, when 99 vessels carrying 287,399 tons of freight, or an average of 2,913 tons each, passed through the canal. The total value of the freight carried was estimated by the shippers at $340,000,000, while the amount paid for its transportation was $21,552,894. As the average distance carried was 843 miles, the cost of carriage figures out at less than one mill per ton per mile.

As an indication of the great intensity of this traffic it may be stated that although the number of ships passing through the canals were given as 16,120, the actual number of different ships was only 886, which shows that each ship must have passed through on the average eighteen times. As another indication of the immensity of the operations, it may be mentioned that the registered tonnage passing through the canal during the season was three-quarters as great as the entire registered tonnage of all ships in all the mercantile navies of the world, and is upward

THE NORTHWEST IN THE POE LOCK.
(Photo by A. E. Young.)



WHALEBACKS IN THE POE LOCK.
(Photo by A. E. Young.)

of four times the entire registered tonnage of all the ships in the merchant marine of the United States, and about thirty times the total tonnage of American ships engaged in the foreign trade.

It is proposed to hold a celebration to commemorate the fiftieth anniversary of the opening of this canal, the celebration taking place at Sault Ste. Marie, Mich., on August 2 and 3, 1905. The plan for the first day includes sports of various kinds on the water and on shore, with a display of fireworks in the evening. On the second day there will be given addresses by representatives of the United States, of the Dominion of Canada, and of some of the state governments, ending with a reception by the governor of Michigan. The general charge of the celebration, including the erection of a permanent memorial at Sault Ste. Marie and a preparation of the history of the canal, is entrusted to the Lake Superior Canal Semi-Centennial Commission of 1905, the members of which as appointed by the governor of Michigan are Peter White of Marquette, president; Horace M. Oren of Sault Ste. Marie; and Charles Moore of Detroit, secretary and treasurer.

A BLOCKADE, DUE TO A FEW HOURS' STOPPAGE AT THE LOCKS.
(Photo by A. E. Young.)

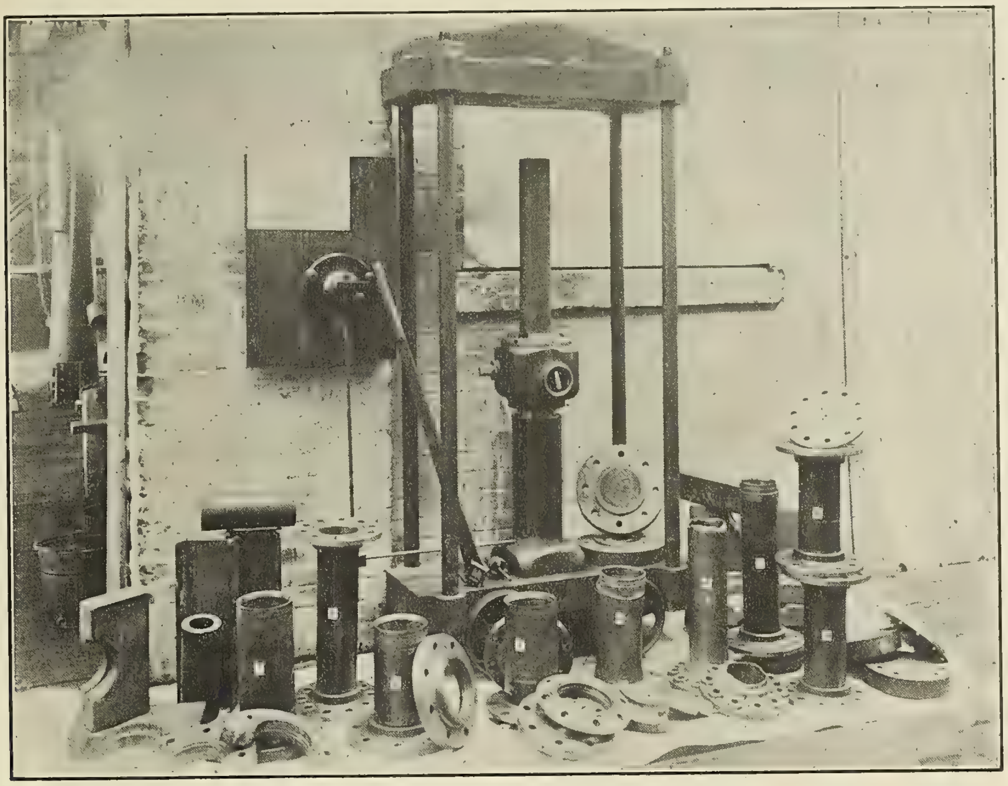


FIG. 1. APPARATUS AND TESTED PIPES AND FLANGES.

TESTS OF COLD-ROLLED FLANGED-PIPE CONNECTIONS.

BY LUTHER D. LOVEKIN.

In order to demonstrate the practicability of copper pipes rolled into steel flanges by machinery, and also to demonstrate the ability of machinery to place flanges on steel pipe, such as is used by our Navy Department at present, as well as other miscellaneous forms of joints, a series of tests was conducted, the results of which are herewith appended. These tests have clearly shown the great advantage of cold-rolled joints for all copper pipe, as compared with the old practice of brazing the pipe to the flange (which is both expensive and dangerous); and the rolling of steel pipes into flanges has met with such general favor among those who witnessed the tests that it is believed screwed pipe joints on sizes of over 6 inches diameter will be eliminated at an early date. In all cases of cold-rolled joints for all steam pressures, whether superheated or otherwise, it appears that the question of expansion and contraction can be eliminated in considering the adaptability of these joints.

The tests were made to ascertain the strength and tightness of pipes and joints made by expanding the pipes into flanges by flowing or extruding the metal cold into grooves of a special form, and also to form a comparison with brazing metal flanges, which were brazed to the pipe. The test pieces were made to fulfill actual working conditions as nearly as possible; the number and size of bolts, the size of flanges, etc., being the same as used in regular practice in most cases.

The tests were made at the works of Dienelt and Eisenhart, Inc., Philadelphia, by Mr. Fred. Kauffman, who arranged the apparatus as shown in the accompanying cuts. Owing to the number of tests it was impossible to complete them all on Tuesday, February 14, and those present agreed to accept the reports of Captain Bergdorff, U.S.N., and Naval Constructor J. W. Powell, for the balance of the tests, and Thursday, February 16, was fixed to complete them.

The apparatus used in making the tests is fully shown in Fig. 1. It consisted of a hydraulic jack of 40 tons capacity (shown in Figure 2) set between two heavy cast-iron plates, held about five feet apart by four bolts 1 3-8 inches in diameter; the cylinder of the jack was drilled and tapped at the bottom for an 1-8-inch standard gas-pipe thread, and an 1-8-inch standard iron pipe-size copper pipe connected the jack with the pipe to be tested by hydraulic pressure; in this pipe line was connected a heavy tee, from the side leg of which an 1-8-inch pipe connected to a Shaw differential plunger mercury test gage, for accurately indicating the pressure per square inch created by the jack pump.

For the pulling tests a cast-iron equalizing plate in halves 2 inches thick rested on two short pieces of 6-inch I-beams, these in turn resting on two pieces of 3-inch square steel, with two vertical 3-inch diameter struts resting on the under face of the top plate of the press as shown. The equalizing plate mentioned is a flat plate, in halves, cut out to clear the outside diameter of the test pipes, and is intended to equalize or distribute the pulling load over the entire flat surface of the flange on the test pipe, and thereby prevent breaking the same, due to excessive bending, had the flange been supported on two sides only.

In making the hydraulic tests the above described frame used for the pulling tests was removed and in its place a 4-inch diameter bar of sufficient length to reach from the top of the jack to the under side of the top plate of press was used; the test piece was filled with water and connected to the free end of the 1-8-inch pipe. Upon working the jack pump the 4-inch bar prevented the ram from raising in the cylinder of the jack, thereby creating pressure in the test piece; the pressure was accurately shown by the gage before mentioned.

In making the pulling tests, the piece of pipe used to connect the test piece to the tee was removed and the tee plugged; thus leaving the 1-8-inch pipe connection from the jack to the gage only; the 4-inch bar from the top of the jack to the under side of the top press plate was also removed, and in its place the above described frame was set, with the test piece in the center. One blank flange was bolted on the top end of the test pipe, and between this and the head of the jack a round bar, a few inches longer and somewhat smaller in diameter than the inside of the test piece, was placed. On working the jack pump the ram raised and pushed the center bar against the blank flange on the top of the test pipe, raising this and also bringing the regular flange on the lower end

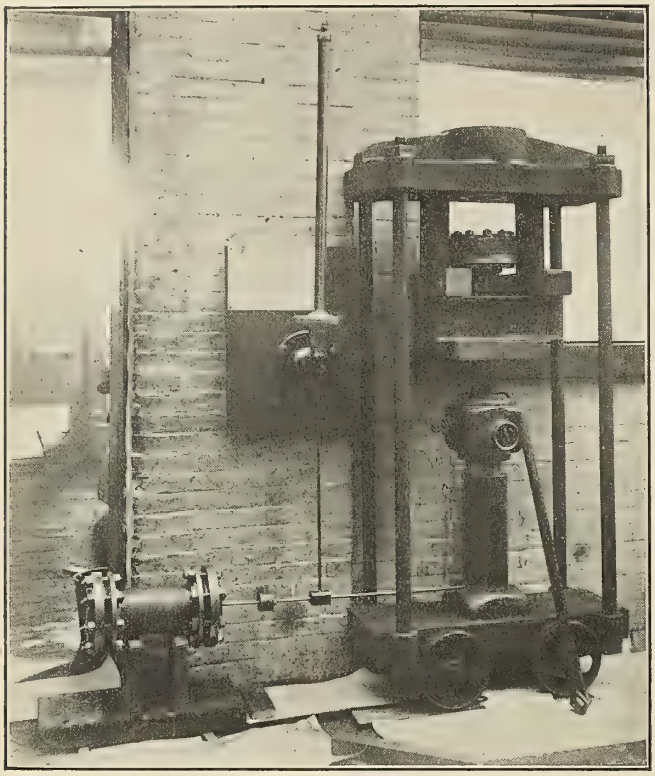


FIG. 2. APPARATUS READY FOR TESTING.

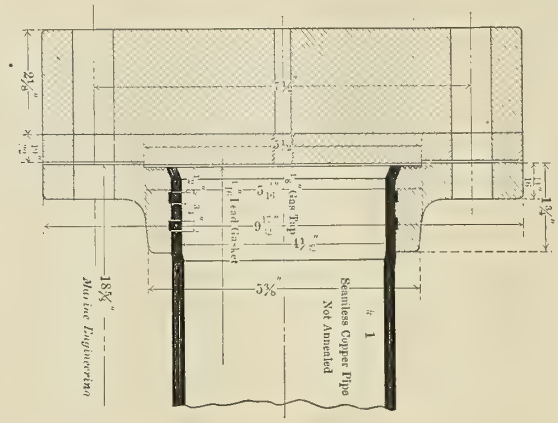
of the test pipe in contact with the equalizing plate and frame resting on the under side of the top plate of the press, thus pulling the pipe apart or out of the flanges as the results show; the pressure in the jack being read, as before, on the gage, and from the pressure the total tons load was read off a table calculated for every 100 pounds per square inch on the jack ram, this ram being of 4 13-16 inches diameter.

By agreement with Naval Constructor Powell and Captain Bergdorff no allowance was made for the weight of the ram, frame, and test piece, in the results of the pulling tests, as the readings taken from the gage were not close enough to consider such refinements. In order to fully satisfy the inspectors and their departments as to the accuracy of these instruments, Mr. Powell sent his assistant to the place of manufacture to test them. On Friday, February 17, we placed these gages under all manner of tests, comparing them with Bourdon spring gages, and other mercury test gages, and finally placed them in connection with a plain mercury column which measures exactly 68 feet and 7-8 inch high; calling 2.04 inches of mercury equal to 1 pound pressure, this equals 400.4 pounds; the gages tallied exactly with this pressure, and fully satisfied the inspector as to their accuracy.

Accurate full-size drawings have been prepared of each test piece, the numbers on the same corresponding with the order in which the tests were made. A photograph of all the test pieces is also shown, in Figure 1.

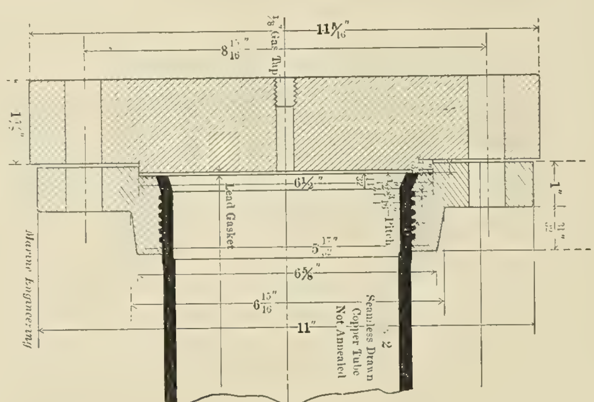
On Tuesday, February 14, previous to making the tests, the large expanding machine, capable of working pipe 30 inches diameter, was placed in operation and fully explained to all present, a piece of 20-inch wrought-iron pipe being expanded, flared, and faced complete in 32 minutes.

Piece No. 1 was of 4 inches inside diameter, seamless copper tube, 3-16-inch thick, unannealed, expanded in drop-forged steel flanges furnished by the New York Shipbuilding Company; the flanges are a standard design used for 100 pounds working pressure, as shown on figure. This was given a hydraulic test and everything was perfectly tight until 3,200 pounds per square inch was reached, when it began to leak at the gasket, but the pressure was increased to 3,600 pounds, after which the test was stopped; the expanded joint was perfectly tight, and apparently the flanges had not started off the pipe, although after disconnecting they were found to be loose on the pipe, the metal in the flange having been strained beyond the elastic limit. This gave a factor of safety of 36 for this piece, as compared with the working pressure.



This same piece was re-expanded and given a pulling test on February 16, one flange starting to pull off the pipe when 24.73 tons was reached; this corresponds to 4,300 pounds per square inch internal pressure in the pipe, and gives a factor of 43 as compared with the working pressure. Complete rings were sheared off the copper in the grooves in flange.

Piece No. 2 was of 5 inches seamless drawn copper tube unannealed, 1-4-inch thick, expanded into forged steel flanges furnished by the Scully Steel and Iron Company, of Chicago, as used for 200 pounds working pressure; all as shown on figure. On February 14 this was given an hydraulic test; everything was perfectly tight until 1,800 pounds was reached, when it began to leak in the expanded joint and started one flange off the pipe. This gave a factor of 9, but pipe was not fully expanded.

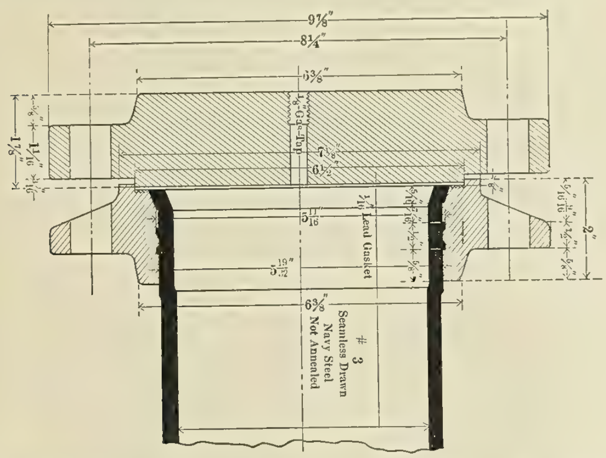


This was re-expanded and again given a second hydraulic test, on February 16, when 2,800 pounds was the maximum, when it began to leak at the gasket, the expanded joint remaining perfectly tight; this gave a factor of 14. It was again given a pulling test on this date, without expanding, starting one flange off the pipe when 15.18 tons was reached. On removing the flange the joint shows that the metal had not flowed well into the grooves, only two out of the six rings were holding, and these were only partly filled with the copper. This accounts for the low pressure this piece stood. This type was purely an experimental joint.

Piece No. 3 was of high grade, seamless drawn steel tube, the same as used for high-pressure steam by the United States Navy Department; it is 5-inch pipe, 17-64-inch thick, and was expanded, unannealed, into forged steel flanges of an entirely new design suggested by Mr. Lovekin; flanges were furnished by the New York Shipbuilding Company, as shown on figure. This was intended for high pressures, up to 300 pounds per square inch; all calculations for design are fully shown in figure. On February 14 this was given an hydraulic test; on reaching 600 pounds it began to leak slightly in the gasket, but the pressure was increased to 3,800 pounds, when leak in gasket overcame the pump supply and test was stopped. The expanded joint was perfectly tight. This gave a factor of 13. (See later tests.)

On February 15, new lead gaskets 1-16-inch thick were applied in place of the copper, and a second hydraulic test given the piece. Four thousand three hundred pounds was reached when it began to leak again at the gasket, the expanded joint remaining perfectly tight.

On February 16 the bolts were tightened up and pressure again applied. At 4,800 pounds one flange was drawn off the pipe about 1-2 inch; again applied pressure to force the flange entirely off, and it again stood 950 pounds without a leak. In the first test on this the expanded joint was perfectly tight until flange started to pull off the pipe. This gave a factor of 16. On removing the flange it was found that the metal had flowed very little into the grooves in the flange, while the flaring was perfect. This was due to the metal in the pipe not being annealed, and the flange having no backing whatever to support the same.

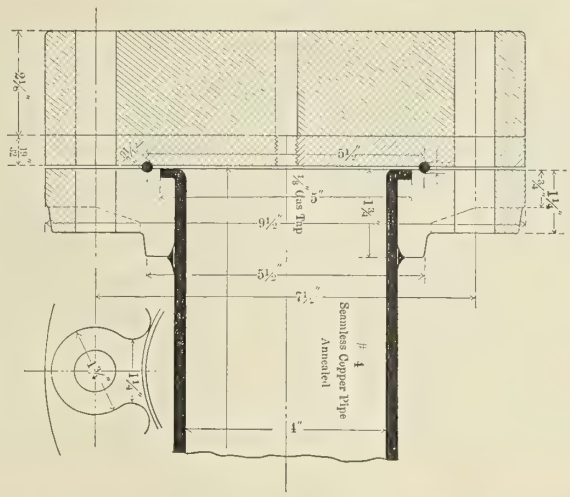


On February 20, wishing to remove the flange that remained intact on the other end of this pipe, there was applied all the pressure a man could exert on a 40-ton jack, in the opposite direction to the pulling tests, and managed to start the pipe in the flange about 1-64 inch, and finally had to cut the tube out with a chisel and hammer. In cutting this tube where it had been expanded, the metal was very hard and tough, and was not in the least flaky or brittle; showing the expanding had not lessened the strength of the material to any appreciable extent, and that no crystallization had taken place.

Piece No. 4 was of 4-inch seamless drawn copper tube 3-16-inch thick, hammered, beaded over, and brazed into composition flange by New York Shipbuilding Company, and in a 200-pound joint; all as shown on figure. On February 14 this was given an hydraulic test and began to leak at the gasket at 1,800 pounds, but the pressure was increased to 2,200 pounds, when leak increased beyond the capacity of the pump. The pipe began to bulge at 600 pounds, near the brazing at each end, and reached the elastic limit of the metal at 900 pounds. The pipe was stretching lengthwise all the time; it was very much distorted at 2,200 pounds. Elongation was 1-8 inch and increase in diameter 1-4 inch. This gave a factor of 11, but the elastic limit was reached with a factor of 4.

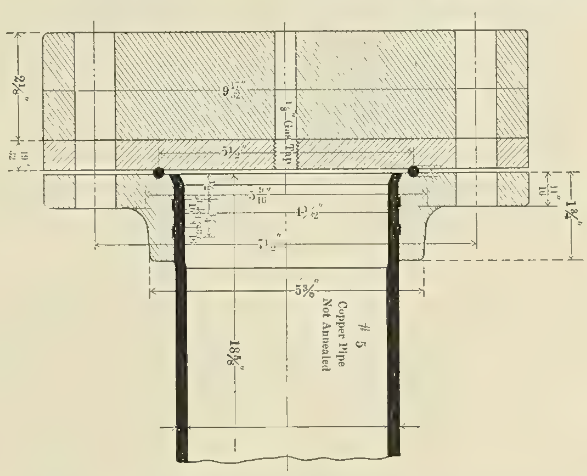
This piece was also given a pulling test, and the pipe pulled apart about 1 inch from the flange at 29 tons; this corresponds to an internal pressure of 5,000 pounds per square inch. During this test the pipe increased in length 29-32 inches and decreased in diameter 7-16 inch. The brazing was cracked at each end.

Before this test there were some comments on this test piece, by one of the supervising inspectors, to the effect that this pipe



appeared to have been overheated in brazing, and that it was not a fair example of brazed work. After the test the pipe at the fracture was hammered down, in an effort to break some pieces off; but it was impossible to do so, showing the life of the copper to be unimpaired.

Piece No. 5 was of 4-inch seamless drawn copper pipe, 3-16-inch thick, unannealed, expanded into forged steel flanges, furnished by New York Shipbuilding Company, and is a fair sample of joint for 100 pounds, as shown on figure. On February 14, those present requested that the pipe be given a pulling test to compare with the pulling test on the brazed joint No. 4. This was stated to be hardly a fair comparison, as this sample was

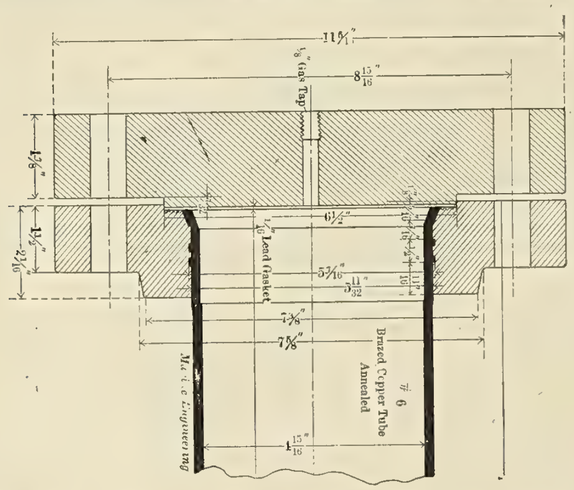


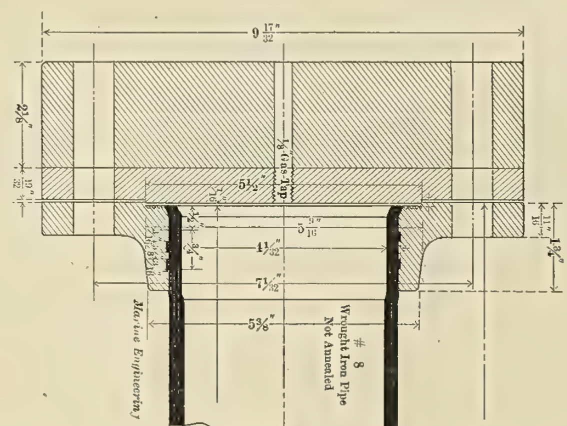
not designed for a great pulling load or high pressures, and being expanded would not compare with No. 4, which was practically one solid piece of metal; but to the surprise of every one it stood 28.17 tons, when one flange started off the pipe, shearing complete rings off the copper pipe in the grooves in the flanges. This was equal to an internal pressure of 4,940 pounds per square inch and gives a factor of 24.7; this is .83 ton less than the brazed sample No. 4.

Piece No. 6 was of 5-inch brazed copper pipe, annealed, 3-16-inch thick, expanded into cast-iron flanges, furnished by Dienelt & Eisenhardt, and was intended for 200 pounds working pressure, being shown on figure. On February 16, this was given a pulling test and pulled the pipe apart in one flange at 34.36 tons; this is equal to an internal pressure of 3,850 pounds per square inch, and gives a factor of 19. The expanding was perfect. To see what initial strain, if any, was set up, due to expanding the pipe into the cast-iron flanges, they were removed from pipe, laid on the floor, and struck with a 16-pound sledge swung by a very strong man, and it required two or three blows to crack them, thus giving ample proof that the initial stress set up in the flange was not sufficient to materially weaken the same.

SUMMARY OF TESTS.

Piece No.	Inside Diameter of Pipe.	Thickness of Pipe.	Material.	Kind of Joint.	Designed Working Pressure.	Kind of Test.	Hydraulic Pressure per Square Inch.	Pulling Load in Tons.	Internal Pressure per Square Inch Corresponding to Pulling.	Factor Comparing Destructive Pressure with Working Pressure.	Remarks.
1	4″	$\frac{3}{16}$″	Seamless copper.	Expanded.	100 lbs.	Hydraulic.	3,600 lbs.	.....	....	36	Leaked in gasket. Perfectly tight in expanded joint. Flanges loose on pipe.
1	4″	$\frac{3}{16}$″	"	"	100 "	Pulling.	....	24.73	4,300 lbs.	43	One flange off pipe. Was re-expanded for this test.
2	5″	$\frac{1}{4}$″	"	"	200 "	Hydraulic.	1,800 lbs.	.....	....	9	Started one flange. Leaked in expanded joint.
2	5″	$\frac{1}{4}$″	"	"	200 "	"	2,800 "	.....	....	14	Was re-expanded. Leaked in gasket. Otherwise tight.
3	5″	$\frac{17}{64}$″	Seamless steel.	"	300 "	"	3,800 "	.....	....	12.7	Leaked in gasket. Otherwise tight.
3	5″	$\frac{17}{64}$″	"	"	300 "	"	4,300 "	.....	....	14.3	Leaked at new gasket.
3	5″	$\frac{17}{64}$″	"	"	300 "	"	4 800 "	.....	....	16	Expanding tight. Pulled one flange loose.
4	4″	$\frac{3}{16}$″	Seamless copper.	Brazed.	200 "	"	2,200 "	.....	....	11	Bulged very badly. Leaked at gasket. Elastic limit reached at 900 lbs.
4	4″	$\frac{3}{16}$″	"	"	200 "	Pulling.	....	29	5,000 lbs.	25	Pulled apart 1″ from brazed joint. Brazing cracked, flanges dished.
5	4″	$\frac{3}{16}$″	"	Expanded.	100 "	"	....	28.17	4,940 "	24.7	Pulled one flange off pipe.
6	5″	$\frac{3}{16}$″	Brazed copper.	"	200 "	"	....	34.36	3,850 "	19.2	Pulled pipe apart in flange.
7	5″	$\frac{17}{64}$″	Seamless steel.	"	200 "	"	....	32.98	3,700 "	18.5	Pulled one flange off pipe.
8	4″	$\frac{1}{4}$″	W. I.	"	100 "	Hydraulic.	2,000 lbs.	.....	....	20	Re-expanded. Pulled one flange off pipe.
8	4″	$\frac{1}{4}$″	W. I.	"	100 "	"	3,300 "	.....	....	33	Expanding tight. Leaked at gasket.
9	4″	$\frac{1}{4}$″	W. I.	"	100 "	"	3,100 "	.....	....	31	" " " " "

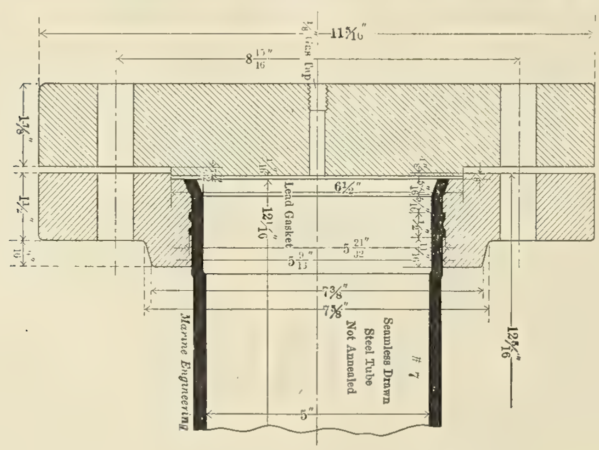


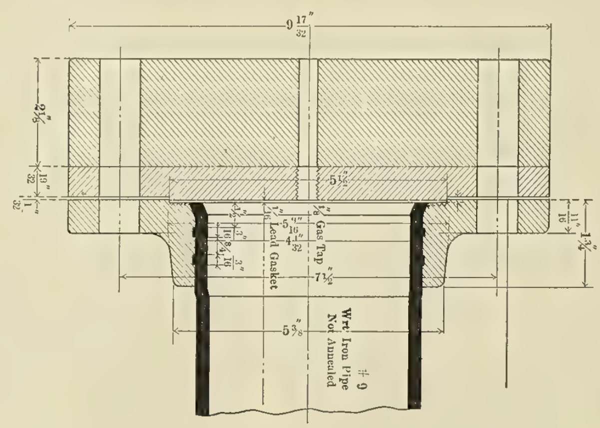


Piece No. 7 was of 5-inch seamless drawn steel tube, 17-64-inch thick, unannealed, expanded into cast-iron flanges, furnished by Dienelt & Eisenhardt, and intended for 200 pounds working pressure. On February 16, this was given a pulling test and started one flange off the pipe at 32.98 tons; this corresponds to an internal pressure of 3,700 pounds per square inch and gives a factor of 18.5. The expanding was perfect, but the metal flowed into the flange grooves very little. The hammer test to crack the flanges gave the same results as with No. 6.

Piece No. 8 is of 4-inch standard wrought-iron pipe, about 1-4-inch thick, expanded into forged steel flanges, furnished by the New York Shipbuilding Company, and is a standard 100-pound pressure joint. This had been re-expanded, the flanges having been loosened from a previous preliminary test. On February 16, this was given an hydraulic test, and was perfectly tight in the expanded joints up to 2,000 pounds per square inch, when it began to leak and started one flange off the pipe. This was not to be accepted as to what the joint would stand if new, as it was made to find out what a joint would stand after it had been excessively strained, so as to loosen the flanges and re-expanded again, and for this purpose shows exceedingly good results.

In preparing for these tests preliminary trials were made on February 11 and 13 on pieces No. 8 and 9 (see figures here-





with) to determine how the gaskets would hold, also the strength of the light forged steel blank flanges, and these results show what pressure this type of joint will stand when new. Pieces No. 8 and No. 9 are 4-inch standard wrought-iron gas pipe, about 1-4-inch thick, expanded into forged steel flanges, furnished by the New York Shipbuilding Company, and intended for 100 pounds working pressure. Piece No. 8 stood 3,300 pounds hydraulic pressure with expanded joint perfectly tight, but leaking at the gaskets. Piece No. 9 stood 3,100 pounds hydraulic pressure with expanded joints perfectly tight, but leaking at the gasket. In both tests, after disconnecting, the flanges were found to be loose on the pipes, showing the limit of elasticity of the flange had been reached; this gives factors of 33 and 31.

Under these tests the blank flanges bulged about 3-16 inch, and it was found necessary to add the cast-iron flanges, shown on the drawings, to strengthen them and prevent the excessive springing. In all the hydraulic tests the pressures were not put on and released instantly, but wherever the joint did not pull apart it was kept at maximum for several minutes. In the table is a tabulated summary of these results for reference and comparison.

Openings in the United States Navy.

We are informed by the Navy Department that there is a considerable demand in the service for machinists and machinists' mates, these of course gradually leading up to the grade of warrant machinist.

Machinists' mates of the second class must be machinists by trade, familiar with the names and uses of the various parts of marine engines and boilers, able to perform work with the various tools in the machine shop, including bench work, and must be able to write legibly and have some understanding of arithmetic. Candidates for this class, who are not required to have any experience at sea with marine engines, will be assigned to duty as water tenders and oilers. The pay for this class is $40 per month.

Machinists' mates of the first class, whose pay is $55 per month, must have the same qualifications as those of the second class, and in addition must have had experience at sea with marine engines for a period of at least one year. Those of the second class are promoted to the first class as soon as eligible.

Chief machinists' mates, whose pay is $70 per month, obtain their rank by promotion from the other two ranks as occasion offers, it not being considered policy to enlist anyone with this rank unless he has previously earned the rank on a permanent appointment.

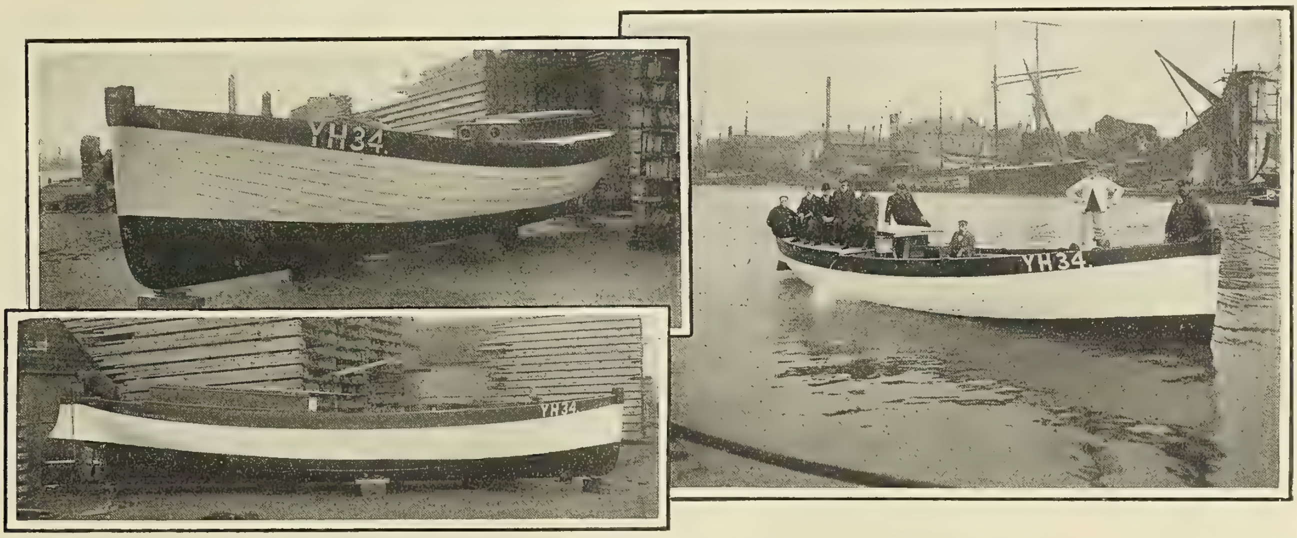
Warrant machinists are paid from $1,200 to $1,800 per annum, according to length and condition of service. This rating is obtained by promotion from the last mentioned, and the position is that of a warrant officer.

There is frequently a demand for boiler makers in the navy, though at the present time the navy is pretty well supplied with men of this rating. The pay is $65 per month, and applicants for enlistment must be competent boiler makers by trade; if they have had previous sea experience that fact will operate to their advantage. The same may be said of blacksmiths, for whom the pay is $50 per month.

It is needless to state, of course, that all men on sea duty are furnished with food, lodging, and medical attention free of charge, and that a free outfit of clothing is furnished every enlisted man of the navy on the occasion of his enlistment.

Motor Fishing-Boat Reaper.

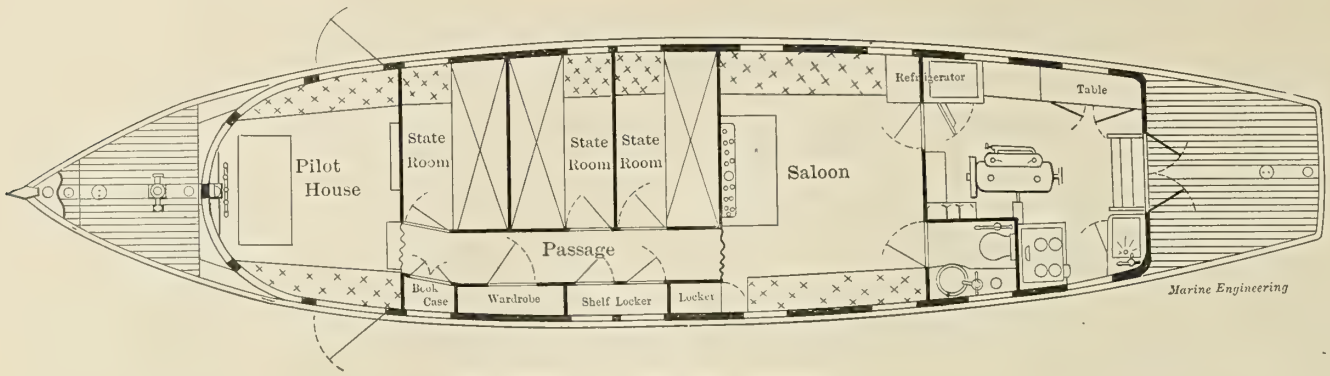
This boat was built at Great Yarmouth, England, for Mr. H. Johnson, of Sheringham, and is used for fishing purposes in general. Previous boats for fishing and "whelking" have been of about 13 feet in length and propelled by lug sails. This boat has been built to reach the outside part of the territory, and at the same time to do a little trawling. She measures 34 feet on the keel and 36 feet over all, with a beam of 9 feet 9 inches, and a depth of 3 feet 11 inches. In order to be able to make use of shallow harbors along the coast the boat has the small draft of 2 feet 6 inches. There is an oak keel 4 1-2 inches wide, with pine keelsons and 1-2-inch oak planking.



THE MOTOR FISHING-BOAT REAPER.

The engine is of 15 horsepower, of the Gardner kerosene pattern, with two cylinders each having a bore of 5 1-4 inches and a stroke of 6 inches. The revolutions per minute are 700. A Gaines reversible propeller is fitted, and is so arranged that low speed can be obtained with it without slowing the engine, by placing the blades in a nearly neutral position. The expected speed of the boat was from 7 to 8 miles per hour, but no difficulty is experienced under good conditions in making 9 miles, while at one time, in a hard gale, she made 10 miles against the sea in just under 1 1-2 hours.

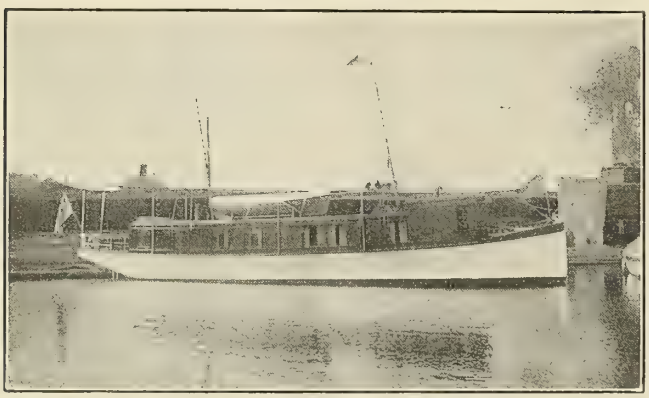
Chief-engineer Charles A. McAllister, of the revenue cutter service, who has been temporarily holding down the chair of engineer-in-chief during the illness of Capt. John W. Collins, was recently appointed engineer-in-chief permanently upon the retirement of Capt. Collins. Mr. McAllister has the distinction of being the youngest officer who ever held this important post, and it is the universal testimony of those with whom he has been intimately associated in his work that he is in all respects qualified to properly discharge the duties devolving upon him.



ACCOMMODATION PLAN OF MOTOR BOAT BEST EVER.

The Motor Boat Best Ever.

The drawings of the motor boat *Best Ever,* owned by Mr. H. S. Peters, of Dover, N. J., and built by Hiram Weller's Sons, of Trenton, N. J., show a boat with a length over all of 48 feet 6 inches, a beam of 10 feet 6 inches, and a draft of 2 feet 10 inches, with 5 feet 6 inches freeboard at the bow and 2 feet 7 inches minimum freeboard. This craft was designed as a safe and comfortable family cruiser for work in all kinds of weather, which accounts for the considerable beam, and for the fact that the midship section is quite flat, thus allowing the light draft and permitting operations in shallow waters. It will be noticed from the accommodation plan that three staterooms are provided, each of which has upper and lower berths, with a chest of drawers under lower, while the sofas in both pilot house and saloon could, if necessary, be utilized for sleeping accommodations. The pilot house, 6 feet 9 inches long, has an outlook in all directions, while under it are the water tanks. The platform for the wheelman is also fitted up to be used as a chart locker under the grating. The main saloon, which occupies the full width of the boat, has a length of 7 feet 5 inches and carries at the forward end a folding table hinged to the forward bulkhead; beneath this table are drawers for table linen, cutlery, etc., while above is an oak mantel arranged for the reception of glasses. At the after end of the saloon the built-in refrigerator extends through the bulkhead into the galley, and serves the purpose of a small sideboard.



BEST EVER.

Galley and engine room are combined in one. At the forward end is the refrigerator above mentioned, which has a capacity for 150 pounds of ice, and drains overboard. The range, which is heated with coal, is on the port side just abaft the toilet room opening from the saloon. Propulsion is provided by a Palmer four-cycle, 12-horsepower engine, operating a 24-inch, 3-blade propeller at 375 to 400 revolutions per minute. This power is found to be sufficient for a continuous speed of 7 knots under all ordinary conditions of weather; the best speed under favorable circumstances being about 8.5 knots. The exhaust from the engine is carried outboard on the port side between the range and the toilet room. The boat is lighted throughout by electricity furnished by a dynamo belted to the engine. Gasoline is carried in a cylindrical galvanized steel tank under the forward deck, the capacity being ninety gallons, which is found to be sufficient for a run of about sixty hours, or 450 miles. The watertight bulkhead abaft gasoline tank prevents leakage into the bilge.

This very serviceable little craft has been in operation upward of a year, having covered nearly five thousand miles in her first season, from the Great Lakes and St. Lawrence River on the north to Florida on the south, and has proved herself, by repeated tests, a very seaworthy craft. On one occasion, with the engine slowed down and seas coming across the bows pretty regularly, which is what an ordinary sea will not do, she ran nine miles in two hours against a wind which was reported by the United States Weather Bureau to have had a velocity of from sixty-eight to seventy miles per hour.

The interior is of white pine in natural finish, the outside of the cabin being of cypress with mahogany finish, the plank shears and sprayboards of oak, the deck of selected white pine in narrow widths, the upper deck being covered with canvas. Masts are fitted, carrying leg-o'-mutton sails, for use when occasion demands, and are arranged for rapid dismantling.

The Insufficiency of Marine Feed Cleaners.

BY DAGNINO ATTILIO.

Feed-water filters, as used for marine purposes, very rarely come up to the requirements of the situation. The fact was brought out some time ago in a meeting of the A. S. M. E. that there were no satisfactory filters at that time in use, and conditions have not improved since. It is a fact, however, that when one is willing to incur the expense of installing an appropriate filtering plant, no trouble is experienced with regard to the proper filtering out of the oil from the feed water taken from surface condensers. To cite a case in land practice, a large electric light and power plant in Chicago has been using feed water from surface condensers for more than six years without having any trouble whatever, because of the fact that the filters provided are amply large and properly constructed. It is true that they are quite elaborate and require considerable space, but they obtain the desired result and save large water bills.

At sea many systems are in use, but all appear to need considerable attention and some seem to require cleansing every day. Most of the transatlantic steamers take the feed water through filter tanks filled with coke, sponge, salt, hay, or excelsior, after which it is passed through some patent device before being fed to the boilers. In the new Italian battleship *Regina Margherita* there are four filters of the Harris type, besides a feed-water cleaner inside the feed-water tanks, the total serving for a steam machinery plant of 20,000 horsepower weighing 1,500 tons. The cleaner in the tanks was installed after tests made without it, at the conclusion of which the water surfaces in the boilers were found to be covered with a considerable stratum of grease.

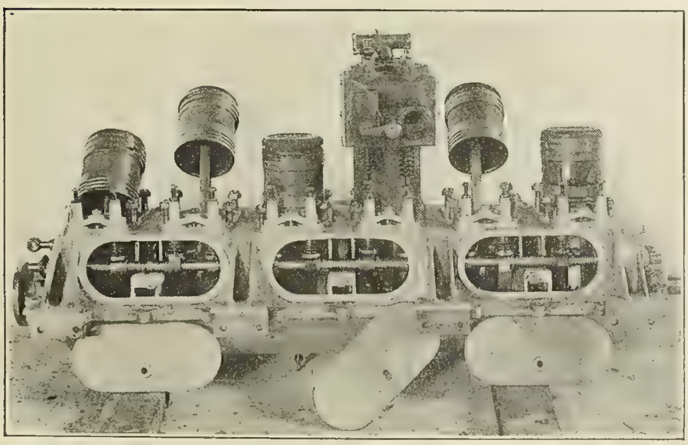
A large part of the trouble is caused by the fact that when an engine is first started up oil is used very liberally in the cylinders, particularly when heavy loads are carried at the beginning. The excess of oil chokes the filter and trouble with the boilers immediately ensues. If a little care were used at the start not to use water from the filters until the cylinders and valve surfaces of the engine were in good condition with regard to lubrication, no such trouble would be experienced; but even after that a minimum amount of oil should be employed. As a rule, engineers use more oil than is necessary, and in many cases the oil used is of a very poor quality. The ideal arrangement would be, of course, the use of no oil whatever.

In modern warship practice the reserve feed water is necessarily a small quantity, while the water consumed in the boilers in a given length of time is frequently a considerable amount. If, then, the feed water at the start be drawn entirely from the tanks rather than from the filters, the reserve supply will suddenly disappear. In a case like this the question of using a very small quantity of oil is of great importance, and it is frequently found possible to do away with oil in auxiliary machinery, particularly in pumping machinery, where the steam furnishes a sufficient film for lubrication.

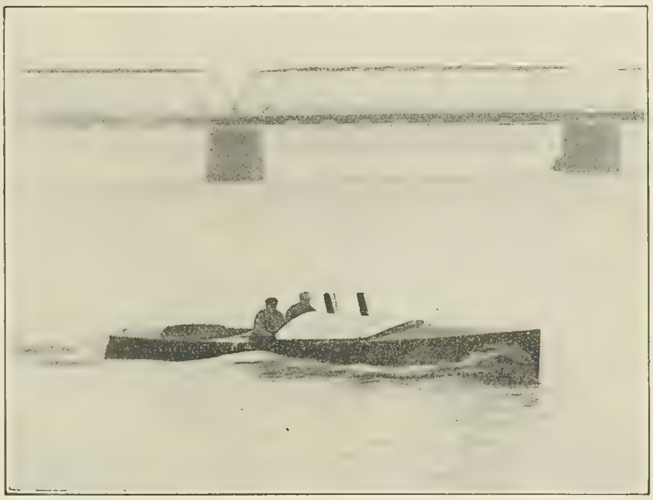
On shipboard, where the space is very limited, it would seem that the only satisfactory solution where filters must be used is the development of some form of chemical filter which will separate the grease from the water in a ready manner, and do it in a small space. The subject is one of great importance, and has yet had no satisfactory solution.

A New Motor Boat.

Built by the Olds Motor Works, of Detroit, with its hull designed by Professor H. C. Sadler, a new motor boat which has recently made its appearance on the Detroit river measures 35 feet in length, 4 feet 6 inches in breadth, and 2 feet 3 inches deep. She is built with a double skin, the inner one being 1-8 inch thick and the outer 3-16 inch mahogany. Except under the weights of the engine space the frames measure 1-2 inch by 3-4 inch. The keel is of white oak in one piece, and the engine floors and beams are also of oak, being continued for some distance aft of the engine space by a gradual taper, thus giving the vessel a very stiff bottom. The decks are made of 3-16-inch mahogany.



The motor is of the six-cylinder vertical type, as shown by our illustration, which gives a view with only one cylinder in place, the other pistons being visible at various angles of inclination. The intake and exhaust valves are side by side; the crank case is made of aluminum with bronze bearings for main shaft. The six-throw crank is of nickel steel, carrying at the front the flywheel and at the rear a flange bolted to the short section of shafting carrying the transmission gear. The reciprocating parts are well balanced and at 1,000 revolutions per minute very little vibration is apparent. The power developed is between 50 and



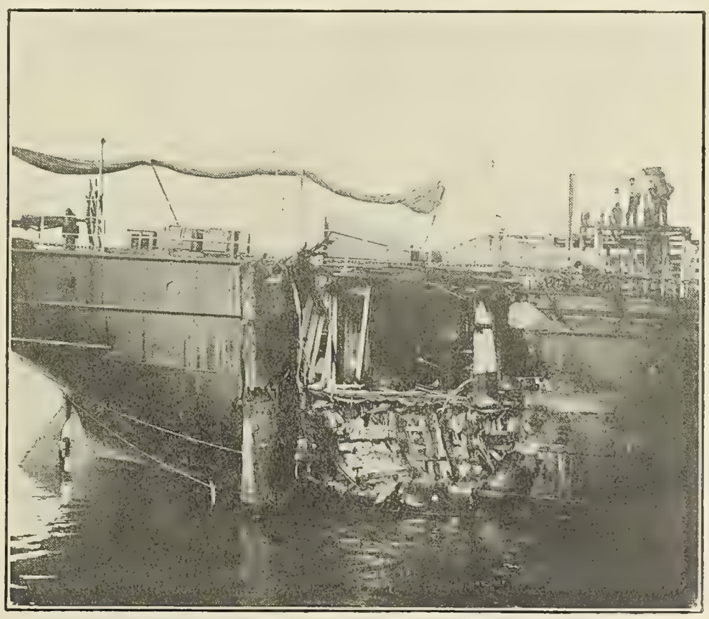
THE OLDS MOTOR BOAT ON TRIAL.

60 horsepower with cylinders measuring 5 by 5 inches. A single carbureter is fitted for the six cylinders and the ignition is of the high-tension type, by means of accumulator and spark coil. The boat has made a little more than 20 miles per hour on the river, and is expected to do still better with the improvements which observation and experience will be sure to suggest.

Collision Between the Kentucky and the Exeter City.

On May 27 the British steamship *Exeter City*, which had just left this port for Bristol, came into collision with the incoming Scandinavian-American liner *Kentucky*, and was so badly damaged that she had to put back for repairs. The occasion of the collision was a heavy white fog which made it impossible for ships to see more than a few feet in advance of their bows. As a result of the blow, which was a glancing one, the after plating on the starboard side of the *Exeter City* was sheared off for a distance of about 15 feet, and, as may be seen in the illustration, was rolled back upon itself in a very peculiar manner. The quarters which were thereby exposed to view are those of the captain. The steamer was repaired in the Erie Basin.

The *Exeter City* measures 285 feet in length, 38 feet in beam, and has a depth of 23 feet 6 inches. Her tonnage is 1,359 net and



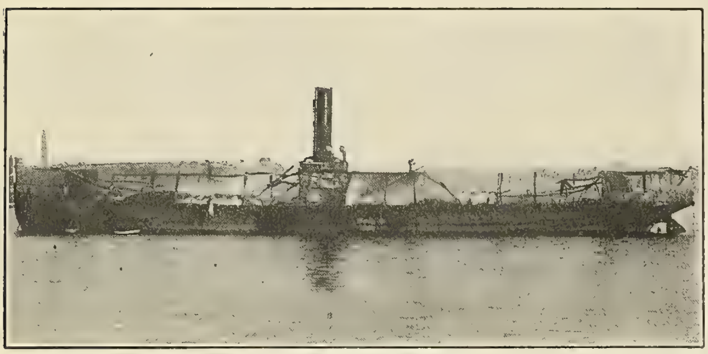
THE EXETER CITY AFTER THE COLLISION.
(Photo by N. Y. Herald.)

2,140 gross. She was built in 1887 by the Blyth Steamship Company, of Blyth, England, and the hull is sub-divided by six steel bulkheads. She is propelled by a triple-expansion engine with cylinders measuring 22 1-2, 37, and 61 inches in diameter and a stroke of 42 inches. The *Kentucky* is also a steel screw steamer measuring 329 feet in length, 45 feet in beam, and has a depth of 32 feet 6 inches. Her tonnage is 2,351 net and 3,622 gross. She was built at Copenhagen in 1897 by Burnester & Wains. She is propelled by a triple-expansion engine with cylinders measuring 24, 40, and 64 inches in diameter, with a common stroke of 42 inches.

Burning of the Steamer Mohawk.

In striking comparison with the total loss in New York harbor by fire of the wooden excursion steamer *General Slocum,* is the damage sustained on the night of November 18, 1904, by the freight steamer *Mohawk,* running from New York to New London. The hull of the *Mohawk* is built of steel throughout up to the main deck, which is also of steel, and it is due to this fact that the furious fire which broke out forward, and rapidly consumed the cargo and wooden upper works, did not completely destroy the vessel.

The *Mohawk* had nearly completed the run to New London, when smoke was noticed issuing from the forward hatch. The vessel was at once stopped in order to lessen the risk of flames spreading (because of the draft of air resulting from the boat's motion), and the fire-fighting apparatus was quickly brought into action. The crew were unable, however, to check the flames, which were spreading rapidly in the inflammable cargo, and within an hour from the time the fire was discovered they had to abandon the ship. The steamer *Boston,* of the Fall River line, which was standing by to render assistance, picked up all of the men but one of the bow watchmen, who perished in his bunk.



THE WRECK OF THE MOHAWK.

The wind and tide carried the burning ship over to the Long Island shore. When the flames had died down the wrecked vessel was towed to an anchorage on the Thames, where the above photograph was taken.

It will be noticed how completely the upper works were consumed. All cargo on main deck and in forward and after holds was burned, and sparks falling down the coal chute ignited the coal in the bunkers. While the heat down below was sufficient to burn every vestige of wooden ceiling in the engine room, the only serious damage to the machinery was a cracked low-pressure cylinder and a few sections of shafting which had to be replaced. The comparatively slight damage sustained is attributed to the fact that no sea water reached the heated pieces. The hull was practically not damaged, but several of the deck plates had to be replaced or straightened.

The contract for repairs, which included a general overhaul of machinery, was placed with the John N. Robins Company, Erie Basin, Brooklyn. The *Mohawk,* which was built at Chester, Pa., in 1896, is of the following general dimensions: length between perpendiculars, 265 feet; beam, molded, 43 feet; depth, 16 feet 8 inches; net tons, 2,151. There is one triple-expansion engine with cylinders 21, 34, and 56 inches diameter by 42 inches stroke, supplied by Scotch boilers, with steam at 160 pounds pressure.

After being almost completely rebuilt, the *Mohawk* has resumed her regular service between New London and New York.

The Mishap to the Zambesi.

The British freighter *Zambesi* left Savannah, Ga., on the 2d of January bound for Bremen, with a cargo which included 750 bales of cotton and 2,700 tons of phosphate rock. Before many hours had passed she was in collision with a derelict which sat so low in the water that it was not seen until too late to avoid the catastrophe. The bow of the *Zambesi* was smashed in, as shown by the accompanying photograph. It will be seen that the stem was broken squarely off in two places, the upper break being at a draft of 21 feet, and the length of the separated section corresponding with the width of the strake of side plating to which it was attached. The forward collision bulkhead saved the ship from any serious danger on the question of foundering. The damage was so serious, however, that it was decided by Capt. Rooney to proceed at once to New York for repairs. The second morning following it was discovered that the cotton in the forward hold was on fire. Live steam was immediately turned into the hold and all vents closed, and the ship proceeded on her way in a gale of wind, with a seriously damaged bow and a burning cargo. The next morning a third form of disaster came near materializing when it was discovered that the relief crew, asleep in the forecastle, were unconscious from suffocation, believed to be due to gas generated from the sulphate rock by the heat of the burning cargo. They were finally revived by means of a mustard emetic and the ship reached port without further mishap.

THE INJURED BOW OF THE ZAMBESI.

(Photo by Hall.)

The photograph was taken in the Erie basin, where the ship has been sent for repairs.

The *Zambesi* was built in 1901 by Bartram & Sons, in Sunderland, England. She is a steel screw steamer, schooner rigged, measuring 350 feet 1 inch in length, 46 feet in beam, and 25 feet 8 inches in depth. The tonnage is 2,415 net and 3,727 gross. Six watertight bulkheads divide the ship into seven compartments, as a security against accident. The machinery consists of one three-cylinder, triple-expansion engine, the cylinder diameters being 24 1-2, 40, and 66 inches, with a common stroke of 45 inches.

The Year's Shipbuilding in the United States.

The Department of Commerce and Labor, through its Bureau of Navigation, reports that in the fiscal year ended June 30, 1905, there were built in the United States 1,301 vessels of a total of 326,213 tons gross, as compared with 1,308 vessels of a total of 401,417 tons gross for the year ended June 30, 1904; while the construction for the year ended June 30, 1903, was 1,535 vessels of 456,076 gross tons, and for the year ended June 30, 1902, 1,657 vessels of 473,981 gross tons. This record shows the continuous decline in mercantile shipbuilding during the present decade.

Of the ships constructed during the last fiscal year, only 42, of 56,777 tons, were steel steamers for ocean traffic, as compared with 51 last year of a total of 99,192 tons, and it is needless to state that aside from the mammoth *Dakota* and *Minnesota* these ships are for coasting trade.

Of the total this year 978, of 101,936 tons, were wooden vessels, and 76, of 161,128 tons, steel vessels propelled by sail or steam; while 247, of 63,149 tons, were barges. The vessels propelled by sails numbered 362, of 74,503 tons; and the steamers 692, of 188,561 tons.

The Milan Exposition of 1906.

To commemorate the opening of the new Simplon Pass through the mountains separating Switzerland and Italy, it is proposed to hold an exhibition under the patronage of the King of Italy in the city of Milan. One of the sections of this exhibition will be devoted to "carriage by water," and is composed of three divisions, the first of which relates to maritime transportation, with its various branches of shipbuilding, fitting-out, equipment, navigation, ports, etc. The second is devoted to inland water carriage, with exhibits of types and methods of operation of river boats, and different systems of traction. The third is concerned with sea and fresh-water fishing and similar industries.

The directors have furnished us with a limited supply of circulars, which we will be pleased to furnish to those interested, upon request.

An Enormous House Cleaning.

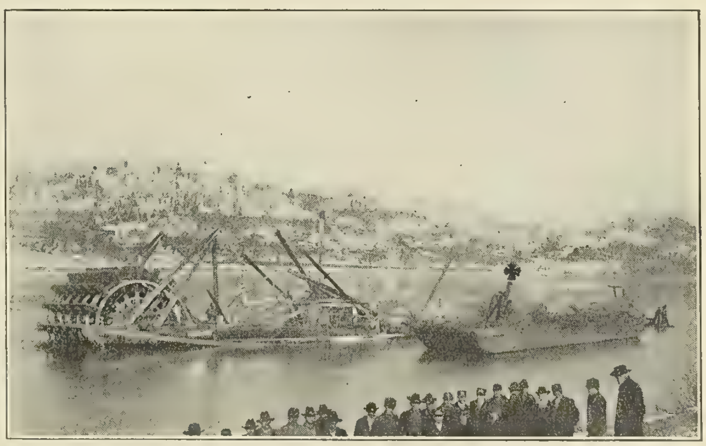
The British Admiralty has recently caused a large amount of comment by condemning and offering at public auction more than 150 warships of various classes, which were estimated to have outlived their usefulness, and to put a larger charge upon the public revenue than their value warranted. Nearly all of these ships were more than twenty years old, but quite a number dated from the nineties, and two small cruisers were launched as recently as 1896 and 1897. It is interesting to note that the entire list includes 12 old battleships, 9 armored cruisers, 15 protected cruisers, 75 unarmored cruisers and gunboats, and nearly 30 vessels of miscellaneous type, the total displacement of the fleet having been quite 350,000 tons. It is estimated that the construction cost of these ships was in the neighborhood of $90,000,000, while the prices received represent, of course, simply the value of the old iron and other materials of construction. One condition of the sale provides that the ships be immediately broken up, which means that they cannot possibly fall into the hands of any other naval "power."

The Burning of the Tow-Boat Defender.

On the night of January 3, the boilers of the tow-boat *Defender*, operating on the Ohio River, and then near Huntington, W. Va., exploded, resulting in the complete destruction of the boat by fire, the killing of ten out of a crew of thirty-six, and the injury of all but one or two of the remainder. The exact cause of the explosion has not been determined with any degree of certainty, though the conclusion reached at the time of the inquest was that the boiler plates were at fault on account of the rules at present in vogue for their manufacture. The requirements are that a plate must show a tensile strength of 70,000 pounds per square inch, and that a specimen measured for a length of 8 inches must show an elongation of 25 percent and a reduction in area of 50 percent. It is claimed by the steel makers that the requirements in the way of tensile strength are at least 10,000 pounds too high, the idea being that the higher tensile strength conduces to brittleness in the plate with consequent inability to withstand the strain of the continual variations in temperature to which a boiler plate in use is subjected.

THE DEFENDER IN SERVICE.

(Photo by the Barrette Portrait Co.)



THE DEFENDER IN RUINS.

We present two photographs, one showing the *Defender* before the explosion, and the other showing the wreck as it appeared the next morning. In the second case a cross has been placed on the photograph indicating the position of the boilers on the boat.

The *Defender* was formerly known as the *S. L. Wood*. She was built in 1881, at Pittsburg, by the Wood Coal Company. The hull was 177 feet in length, 41 feet in beam, and 7 feet 3 inches in draft, the tonnage being 514.

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Lake Shipping of the United States.

We are publishing this month two articles dealing with different phases of what has come to be by far the largest part of the shipping industry of the United States. These two phases may be said to be mutually to a certain extent a case of cause and effect, for certainly the tremendous impetus which shipping on the Lakes has received during the past quarter of a century or more could not have been attained were it not for the magnificent equipment of labor-saving devices of all sorts installed at the various ports for the operations of embarkation and debarkation of the ore, coal and grain which forms so large a part of the entire trade; on the other hand, the immensity of the traffic which called for so intense a production of labor-saving devices could not have attained anything like its present proportions without the intervention of some such means of communication between Lake Superior and the lower lakes as that afforded by the great ship canal and locks at Sault Ste. Marie.

A semi-centennial of the opening of the first of these locks for service is, as we have stated in another column, to take place in the early days of August of this year, and it commemorates not only the mere fact of having opened up a water way for the passage of immense quantities of freight, but at the same time the opening up of a water way which has been very potently instrumental in the development of what might without exaggeration be called an empire. The great grain fields of the Northwest, together with the mammoth mining resources, for iron particularly, but also for coal, have called for an outlet which could have been furnished by the railroads only at an almost prohibitive outlay in expense for freights, whereas the shipping which has been devoted to the purpose of removing the products of the soil has been found to give this service at a cost of considerably less than one mill for every mile each ton of freight was moved.

To give an idea as to the immense growth which has taken place in the traffic to and from Lake Superior during the past forty or fifty years, we have merely to point out that in 1861 the cargo passing through the Soo canals had an aggregate of 88,000 tons, with a value of $6,000,000; ten years later the cargo had grown to 585,000 tons, valued at $13,000,000; in 1881 the figures were 1,586,000 tons and $30,000,000; in 1891, 8,889,000 tons and $128,000,000; in 1901, 28,403,000 tons and $290,000,000; while the present climax was reached in 1903, with 34,674,000 tons and a value of about $350,000,000. It will be noticed that the value per ton has been decreasing through all these years, having been upward of $68 in 1861; $22.25 in 1871; $19.15 in 1881; $14.40 in 1891, and a trifle more than $10 in 1901 and 1903. It will further be noted by comparison with the figures given in the article on the Soo Canal Semi-Centennial that the total cargo moved in 1861 was exactly equal to the average daily movement of iron ore alone in 1904, and was only 70 percent of the average daily amount of freight of all classes in the year last mentioned.

When we come to compare the traffic through this canal with that through such a well-known water way as the Suez Canal, we find that our canal has passed far in advance of the other, from whatever standard of measurement it may be viewed. The number of ships passing through the Soo canal in 1903 was 18,596, and in 1904, which appears to have been a slack year, 16,120; against this we have the Suez canal statistics for 1900, 1901 and 1902 respectively, 3,441 ships, 3,699 and 3,708, while the number in the fiscal year 1905 is given as 4,237. When it comes to a consideration of the registered tonnage of the ships in question, the same sort of thing is manifest; for the Soo canal gave passage in 1903 and 1904, respectively, to 27,738,000 and 24,364,000 registered net tonnage; while the Suez canal in the four years above noted gave passage to only 9,738,000, 10,824,000, 11,248,000 and 13,402,000 tons respectively.

The other side of the question, that relating to the labor-saving devices in the way of loading and unloading machines, may be well illustrated by a comparison between the well-known equipment of the present day and the equipment which was used in 1839 for loading the first cargo of grain ever shipped by water out of Chicago. The grain was shipped from a warehouse which may evidently be considered in some sense a prototype of the modern elevator, now so familiar in all large shipping centers where grain in bulk is handled, and was loaded into the brigantine *Osceola*. The grain was hoisted from farmers' wagons by hand power to the upper story of the building, which was fifteen or twenty feet back from the edge of the pier; it was then transferred by means of a chute, similar to those now in use, to the deck of the vessel, where it was measured in boxes each holding four bushels; these boxes were then covered and placed in the hold; the total cargo amounted to 3,678 bushels. At the present time one of the large grain carriers of the Lakes can receive her cargo of upwards of 200,000 bushels in actually less time than was required for the small cargo of the *Osceola* while the work requires the presence and labor of fewer men, and is accomplished at a much smaller expense.

This same thing holds true in perhaps even greater degree when we come to the consideration of such heavy commodities as coal and iron, and it is necessary merely to note that ships like the *Augustus B. Wolvin* and her big successors of the United States Steel Corporation's fleet, one of which is illustrated on page 335, where she is shown in the act of taking her initial plunge into the water, may be given a cargo of from 10,000 to 12,000 tons in the course of three or four hours, and may be completely relieved of a cargo of this mammoth size in from five to seven hours, to see that in this manner the facilities for handling these enormous quantities of material must be unsurpassed anywhere on the globe.

Small wonder is it then that the concurrent adoption of the most powerful machines for handling cargo of all sorts, installation of water way facilities capable of handling the most congested traffic in a wonderfully short space of time, and the adoption of standard methods in the construction of ships, notably in the spacing of their regular hatchways to fit the machines designed to operate through them, have resulted in the development of a truly wonderful industry, and one of which in every way we have a right to be proud. The only regret which we can utter in connection with this matter is that means have not been adopted looking to the establishment of an ocean traffic commensurate, not only in point of size, but also in adaptability and prosperity, to that which has been developed upon our great fresh water lakes.

The Development of the Marine Turbine.

Ever since 1894, when the Hon. Charles A. Parsons, of London, made his first installation on the triple-shaft yacht *Turbinia*, the development of the steam turbine as a substitute for the reciprocating engine for purposes of marine propulsion has been very prominently in the minds of naval engineers. The *Turbinia*, it will be remembered, was the first craft of any description to make a speed exceeding 30 knots, and the remarkable speed of 34.5 knots which this little boat of 100 feet achieved during the Diamond Jubilee celebration in June, 1897, has been equaled since by only two boats, both of which were over 200 feet long, and both, it may be added, were propelled by the same style of prime mover as that which actuated the nine screws of the *Turbinia*. These two boats were the *Viper* and *Cobra* of the British navy, both of which were lost three or four years ago.

Due to the extremely high rate of revolution required by the steam turbine for its efficient operation, its installation has been attended by many difficulties, and has proceeded at a much slower rate than would have been the case in the progressive times in which we are living had it been more readily adaptable to conditions which it found existent on entering the field. The theoretical best efficiency of the turbine, as is well known, is attained when the linear velocity of the rotating vanes is equal to one-half the velocity of the steam impinging upon those vanes, and as this figure is very high there remain but two alternatives to obtain the results which the best efficiency would require. The first and more obvious of these two is the acceptance of a speed of revolution so high as to enable the vanes to receive the steam under the conditions above set forth. The other alternative is to reduce the speed of rotation of the turbine, either by increasing its diameter in equal ratio to the reduction of rotative speed, or by some other device such as has been so successfully adopted in both the Parsons and Curtis types in connection with compounding. Both these devices have been adopted to a certain extent, though it is to the latter rather than the former that is due the greatest amount of effect in the desired direction.

The resultant turbine is so well adapted for all purposes of marine propulsion where a considerable speed of ship is required that it is now being rapidly installed in ships of all descriptions, from torpedo boats and destroyers to cruisers, and even, if current reports are to be credited, to battleships of the British navy, on the one hand; and to pleasure yachts, commercial steamers making short and quick passages across channels in various parts of the world, and now to the largest sizes of ocean liners, on the other. It is hard to foresee the ultimate limit of the usefulness of this engine, especially in cases where the speed to be maintained has a more or less constant value. There are considerable limitations, however, when we come to apply the turbine to the case of warships of the usual character, which have a maximum speed to be attained in cases of very infrequent occurrence, and a cruising speed, calling for perhaps one-fourth of the machinery power of the ship, to be maintained during at least 90 percent of the time the ship is under way.

ABSTRACT FROM RULES AND REGULATIONS OF THE AMERICAN BUREAU OF SHIPPING FOR SOUND, LAKE, BAY, AND RIVER STEAMERS, YACHTS AND TUGS.

EDITION OF 1904.

ARRANGED BY HARRISON S. TAFT.

1. Measurements.

1. Length. From forward side of stem to after side of inner or propeller post on range of the load water-line.

2. Depth. From base line (top of keel) to main deck (second deck in hurricane-deck vessels) at sides amidships.

3. Breadth. Maximum molded beam.

4. Tonnage.

Steam and sailing yachts. Merchant vessels for passengers only.	$\frac{\text{Length} \times \text{breadth} \times \text{depth}}{175}$
Merchant freight; steam and sail vessels. Merchant freight and passenger vessels. All hurricane-decked vessels. Tug-boats.	$\frac{\text{Length} \times \text{breadth} \times \text{depth}}{150}$

5. Scantling Number for Frames, Reverse Bars, and Floors. 1-2 B + D.

6. Scantlings under tonnage numbers: Keels; stems; stern frames; rudders; bulkheads; deck and hold stringers; outside plating, including flat plate keels; keelsons; stringers and tie plates on deck beams; deck stringer angle bars; deck planking and hold ceiling; anchors; chains; and warps. (See Nos. 7 and 8.)

7. Hurricane-Deck Vessels. Depth for determining the tonnage number for equipment is to be taken to half distance between the top of the second and the hurricane-deck beams at sides of ship amidships.

8. Full Poops; Top Gallant Forecastles and Inclosed Bridge Houses. When the length of one or the combined length of more than one of these structures exceeds 1-2 the vessel's length the tonnage number for scantling increased by 1-8 of itself will be the tonnage number for equipment.

9. Deck and Hold Beams. Scantling of same is to be determined by length of said beams amidships.

10. Stanchions. Scantling of same is to be determined by the depth from top of floors to top of main deck beams amidships.

2. Scarphs.

Scarphs of bar keels, stems, and stern posts should be not less than ten times the required thickness of the bar keel.

3. Stems.

Stems should be equal to bar keels in scantling. They should be rabbetted above the light load water-line for receiving the ends of the shell plating.

4. Stern Frames.

1. Stern frames of sailing vessels, of side-wheel, and of twin-screw vessels, should be equal to the scantling of the bar keel; with the aft end of their scarph with said keel at least one and a half frame spaces forward from the inside of the rudder post.

2. The stern frames of single-screw vessels should be forged in one piece; the part forming the keel between the two posts being of a sectional area equal to twice that required for the bar keel. The middle of the scarph of the stern frame with a bar keel is to be at least two and a half frame spaces forward from the inside of the propeller post.

3. Rudder posts should extend to and be securely fastened to a main-deck beam by a transom floor plate.

4. The thickness of the propeller boss on each side of the hub is to be not less than one and one-half times the thickness required for a bar keel.

5. The inner, or propeller post, when a balanced rudder is fitted, should be of 20 percent greater sectional area than otherwise required.

6. Gudgeons are to be spaced not more than five feet apart.

5. Flat Plate Keels and Center-Line Keelsons.

1. Center line keelsons need not be fitted to vessels of less than 15 tons.

2. Flat Plate Keels.

(*a*) A flat plate keel is to maintain its full midship scantling throughout. It is to lap the stem and stern frames for at least one and one-half frames spaces.

(*b*) When it is worked with a continuous vertical keelson, it is to be secured to same with continuous angle bars equal in scantling to the frames. The vertical keelson should extend above the top of floors a sufficient height so as to be embraced by two continuous fore-and-aft angle bars on the upper side of a horizontal plate stringer, worked on top of floors, on each side of said vertical keelson. Said stringer plates are each to be in width 2-3 the depth of midship floors, but of same scantling as said floors.

(*c*) When the tonnage is 1,250 and over, the continuous keelson is to extend above the top of floors 3-4 of a specified depth, with continuous double angle bars on top. When tonnage is 1,600 and above, a rider plate is to be worked on top of said angles for 3-4 length amidships.

3. Center Line Keelsons with Bar Keels.

(*a*) Vessels of 15, but under 100 tons, fitted with bar keels, are to have a middle line keelson of two angle bars riveted back to back worked on top of floors, all fore-and-aft.

(*b*) When the tonnage is 100, but under 200, a bulb plate of specified depth, worked all fore-and-aft, should be riveted between the above keelson angles; or an intercostal center line keelson, equal to the thickness of floors, can be fitted. The intercostal plates shall be secured to the floors with double clips equal to the reverse bars; they shall extend above the top of floors so as to be embraced by the above two keelson bars.

(*c*) When the tonnage is 200 and over, a center line plate keelson with top angles is to be worked on the top of floors in lieu of the above bulb plate.

When the tonnage is or exceeds 500, a rider plate of keelson-plate thickness is to be worked on top of said keelson top angles for 2-3 length amidships. In lieu of this plate keelson, a regular intercostal center line keelson, as stated under 3-*b*, may be worked as above, extending as far fore-and-aft as possible.

4. Center Through Plate Keel and Keelson.

(*a*) Said plate keel and keelson should extend from the top of floors to below the bottom of floors for a distance equal to the depth of a bar keel; with side plates of specified scantling fitted on each side so as to form a keel; all butts being well shifted from each other. A horizontal plate stringer, equal in width and thickness to the midship floors, is to be worked on the top of floors at the center line, and be secured to the top edge of the vertical keel plate with double clips equal to the reverse bars. When the tonnage is 650 and above double angle bars, riveted back to back, extending all fore-and-aft, are to be worked on top of and riveted to said horizontal plate stringer on the center line.

(*b*) When the plate keel and keelson extends above the top of floors the horizontal plate stringer should be worked in two pieces, one on each side of the vertical keelson; each in width to be 2-3 the depth of midship floors, and be connected to said keelson by two continuous angles riveted back to back embracing the top edge of the vertical plate keelson.

5. Intercostal Middle Line Keelson.

(*a*) When worked with a flat plate keel they are to be secured to same with double clips equal to the frames and have their top edge worked as when fitted to a bar keel as above.

(*b*) In vessels of 1,000 tons or above, a horizontal plate stringer is to be worked on the top of floors on each side of said keelson. Each stringer plate is to be of the same thickness, but in width at least 1-2 the depth of the midship floors; being secured to the intercostal keelson plates by two continuous angle bars similar to above.

6. Continuous plate keel and keelsons are to maintain their midship thickness all fore-and-aft; all other keelsons for 1-2 length amidships. Fore-and-aft of said 1-2 length they may be reduced similar as for floor plates.

6. Frames.

TABLE I.—EXTENT OF FRAMES.

Type of Ship.	One- and two-deck vessels............	All to the upper deck stringer plate.
	In way of a raised quarter: a raised fore: or a topgallant forecastle deck.	" " said deck's stringer plate.
	In way of a full poop or midship bridge house.	To said decks and to the main deck stringer plate alternately.
	Hurricane deck vessels........	All to said deck stringer plate for ⅛ length from stem: abaft of said ⅛ length to said deck and to the main deck alternately.

In way of the lower rigging chain plates all frames should extend to the topmost deck.

1. The frames are to maintain their midship scantling for 1-2 length amidships, except in tug-boats, where the midship scantling is to be maintained throughout. Frames at all watertight bulkheads are to be worked double.

2. The frames are to extend in one piece from the keel to the stringer plate of the deck stated in Table 1, except when cut at the margin plate, as in double bottom vessels.

3. In yachts carrying ballast between the floor plates the frames should be worked double to the upper turn of the bilge in way of said ballast.

4. Scarph pieces equal to the frames and in length at least twice the center depth of midship floors are to be fitted at every frame at the center line except when a continuous center line plate keelson is worked.

5. Frames are to be worked double at the margin plate of inner bottoms when the reverse bars are cut at said point. The doubling pieces are to be long enough to allow of three rivets in each flange on each side of said margin plate.

6. When channel frames are adopted no reduction from their midship scantling will be allowed in the end frames.

7. Floor Plates.

1. Plate floors should be fitted to every frame in all vessels of 15 tons or above, being secured to a continuous middle line keelson with double clips equal to the reverse bars: joggled over the frames and reverse bars. They are to maintain their midship scantling for 1-2 length amidships.

2. For 1-4 length amidships they are to extend up the bilge above the base line to at least twice the center depth of floors, being equal to the depth of the molded frame flange at their ends. Fore-and-aft of said 1-4 length they may be gradually diminished in height at the bilge until they become straight on the upper edge; but in no case are they to be of less depth than their center depth amidships. The floors at the extreme ends of ships should be increased in depth so as to strengthen said ends.

3. In vessels with a good dead rise the floors may be worked straight on the upper edge throughout. Such

floors amidships must measure on the upper edge from bilge to bilge at least 1-4 the molded beam, or be in depth at the center line at least 1 1-2 times the center depth of ordinary floors; no floor plate being of less than this depth throughout the ship.

TABLE 2.—REDUCTION IN WEIGHT OF FLOORS.

Weight of Midship Floors. Lbs.	10 under 16.	16 and above.
For the first $\frac{1}{5}$ length at ends..........	$1\frac{1}{4}$ lbs.	$1\frac{1}{2}$ lbs.
" " second $\frac{1}{5}$ " " "	$1\frac{1}{2}$ "	3 "

Reductions to be figured from weight of midship floors. Said reductions will be allowed in the *fore part only* of vessels upon the Great Lakes with their machinery fitted aft.

4. The floors in the machinery space are to be 2 pounds heavier than otherwise; but in vessels of 15 knots or above, the floors under the engine bed should be 4 pounds heavier.

5. In sailing yachts with an extra heavy bar keel, or with a flat plate keel filled with ballast, the floors throughout should be 2 1-2 pounds heavier than otherwise. When a bent plate keel having lead ballast run into it is adopted, alternate floors for 1-2 length amidships should extend down and be secured to said keel plate with a welded knee clip equal to the frames; said clips lapping the frame ends for at least 18 inches beyond said keel plate.

6. The bulkhead floors should extend above the reverse bars so as to allow sufficient lap for riveting said floors to the bulkhead plating. Limber holes should be cut in all floors so as to provide a free flow for the bilge water to the pumps.

7. Floors, when built of two pieces, should have their butts so arranged that only those on alternate frames are located on the same side of the center line.

8. Transom Floors. At the middle line they are to be at least 1 1-2 times the center depth of the floors amidships, and be equal to same in weight. When the center depth of the transom floor is 12 inches or above it is to be secured to the stern frame with double clips equal to the frames. When said depth is less than 12 inches it may be secured to the stern frame by tap rivets.

8. Reverse Frames.

1. Said frames should be fitted to every floor in all vessels of more than 15 tons. They should maintain their midship scantling for 1-2 length amidships, except in tug-boats, where they are to maintain their midship scantling throughout.

2. In the machinery space of steam vessels the reverse frames are to be worked double on every floor. In vessels of 15 knots or above those on the floors under the engine bed are to be of the same scantling as the main frames.

3. In yachts, with the ballast placed on top of floors, the reverse frames should be worked double on every floor in way of said ballast.

TABLE 3.—EXTENT OF REVERSE FRAMES.

Type of Ship.		Tonnage.	
	All classes...........	Over 100 under 250	All to 6 inches above the upper bilge keelson.
	Steamers...........	250 " 1,000	To the main deck stringer plate and to 6 inches above the upper bilge keelson alternately.
	Sailing vessels......	250 " 500	
	Steamers............	1,000 and above	To the main deck stringer plate on every frame.
	Sailing vessels......	500 " "	

In two-deck vessels the reverse frames which extend to the main deck should extend to the top of the stringer angle at the face of the frames so as to have a one-rivet connection to said angle bar stringer.

9. Bilge, Floor Keelsons, and Side Stringers.

TABLE 4.—TYPE OF BILGE AND FLOOR KEELSONS.

Tonnage.	Lower Bilge.	Upper Bilge.	Floor Keelson.
Under 15	S A	....	....
15 " 50	D A	....	....
50 " 500	D A	D A	....
500 and above.	D A	D A	D A

S A = single angle bar. D A = double angle bars riveted back to back.

1. Bilge Keelsons. The bilge keelsons of Table 4 shall in all cases extend as far fore-and-aft as possible. In double-bottom vessels the lower bilge keelson is to be omitted.

2. Floor Keelsons.

(*a*) The double angle bar floor keelson of Table 4 is to be fitted on top of floors midway between the center line of ship and the lower bilge keelson. When the beam is over 30 feet, or the vessel has but little dead rise intercostal plates are to be fitted in connection with said keelson bars, extending as far fore-and-aft as possible; being clipped to the shell with single clips equal to the reverse bars.

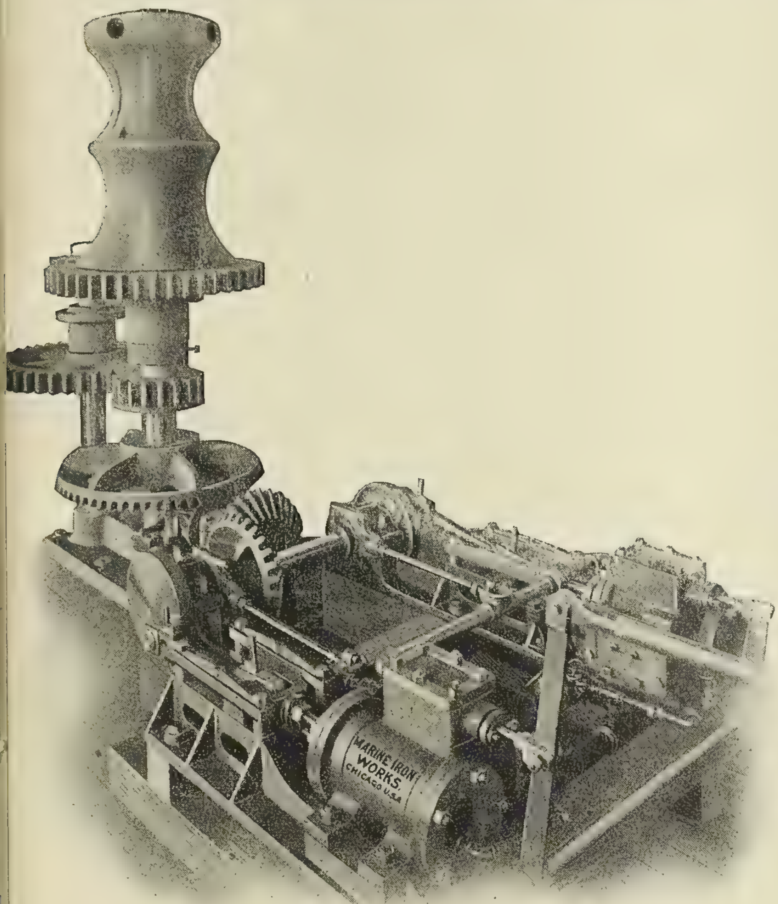
(To be continued.)

ENGINEERING SPECIALTIES.

A New Steam Capstan.

A special type of reversible steam capstan is designed and built by the Marine Iron Works, of Chicago, for river boats. They are adjustable for both speed and power, and suitable for most severe duty, dependability rather than first cost being the prime consideration. The principal dimensions are as follows:

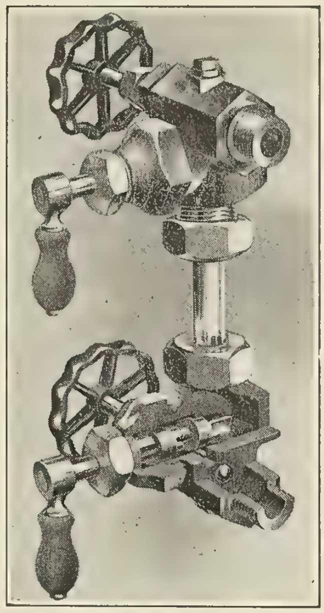
Total outside floor space, 8 feet 5 1-2 inches by 4 feet 2 1-2 inches; two double-acting 5 by 7 reversible engines; height of capstan from deck to top, 2 feet 11 1-4 inches; diameter of large drum, 14 inches; height, 16 1-4 inches; diameter of small drum, 11 inches; height, 19 inches; diameter of shaft, 5 1-2 inches.



The spur gears, bevel gears, bevel pinions, and miter gears are all made of steel, and both drums are made of semi-steel, the object being to obtain the greatest strength at the minimum of weight and space. The weight of capstan complete with engine is 3,700 pounds.

The Shallow Automatic Water Gauge.

Many efforts have been made to devise a boiler water gauge which will automatically shut off the escaping water and steam when the gauge glass breaks. Of the various inventions having this object in view, the Shallow valve seems to fulfill every requirement, and at the same time eliminate the defects that exist in other valves designed for this work. The Shallow gauge is exceedingly simple in principle and in construction. The automatic valve is not subjected to wear except when it is closed through the breaking of a glass, and this occurs only at widely separated intervals. The whole valve is constructed of brass, and the design of the passages and working parts is such that no trouble is experienced from the collecting of sediment or scale, and the consequent sticking of the valve. The action of the Shallow gauge when a glass breaks is so instantaneous that in practically every case some water still remains in the bottom of the

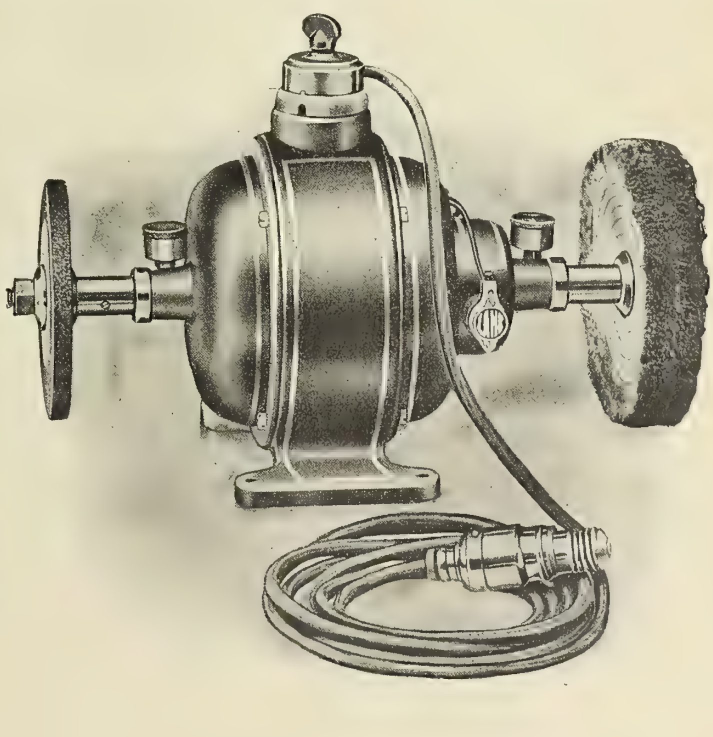


broken glass after the valve closes. A new glass is inserted at once, and the automatic valves brought into position for further service by the simple turning over once of the two automatic handles.

In connection with marine boilers in which very high steam pressures are carried, and about which the fire-room space is very limited, the advantages of the Shallow Automatic Gauge are even greater than in the case of stationary boilers, the danger from flying glass and hot water and the filling of the boiler room with steam being absolutely eliminated. The device is being placed upon the market by the William S. Haines Company, 140 South Fourth street, Philadelphia.

New Grinding and Buffing Motor.

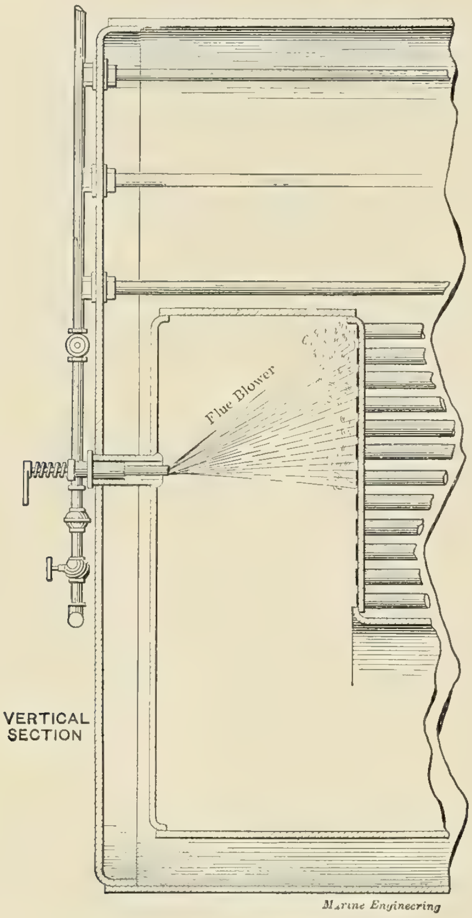
To meet the demand for a portable electrically-driven grinding machine, the Lamb Electric Company, of Grand Rapids, Mich., has been putting out an equipment of which we illustrate a size rated at 1-4 horsepower. The cut will show that the motor is mounted in the middle, with a buffer on one end and grinder on the other, and that the arrangement is so adjusted that it may be



connected up with any electric-light socket. The larger sizes, which run up as high as 2 horsepower, require suitable starting boxes, which are furnished in place of the snap-switch and plug used with the smallest size. The four sizes are built in two different series, one rated at 110 volts and the other at 220, though special voltages may be furnished on order. As the machine is very carefully balanced, smooth running is assured, as well as durability.

The Diamond Steam Flue Blower.

For the purpose of rapidly cleaning boiler tubes without the necessity for shutting down the boilers or reducing the speed of the engine, the Diamond blower is fitted as shown in the accompanying illustration. It is claimed that this practically does away with the work of the firemen in cleaning the tubes, absolutely prevents the accumulation of soot, and saves in a short



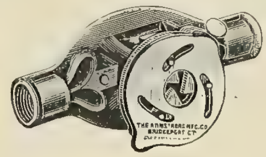
time its own cost by the saving of the hose which would ordinarily be used in connection with the old method of cleaning. It is further stated that a thorough cleaning of all the tubes in the boiler will take not more than five minutes, because in each operation a large cluster of tubes is cleaned all at once.

The Svea Caloric Engine.

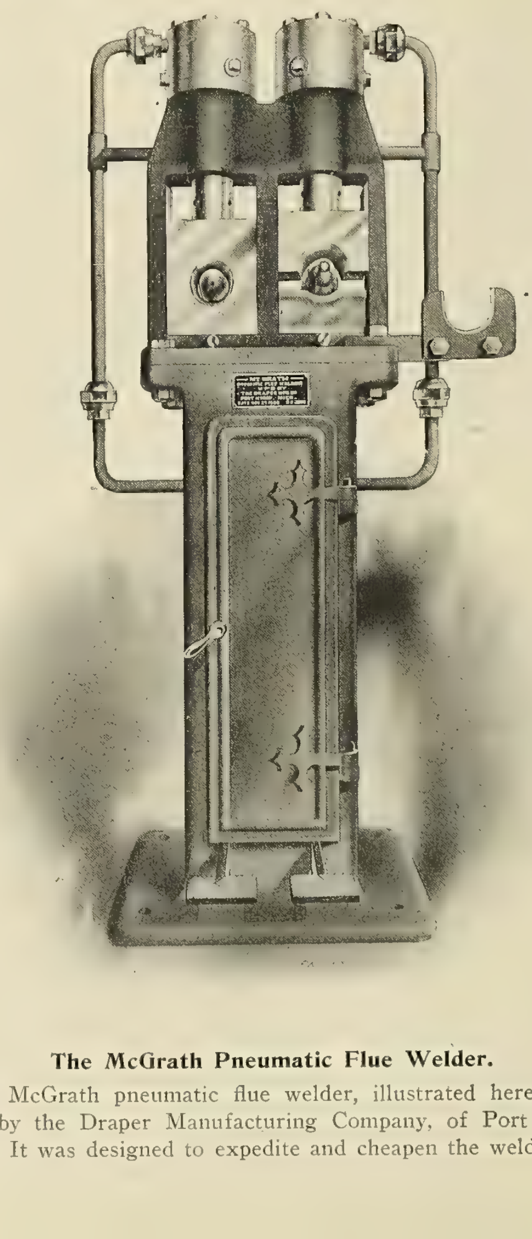
The external combustion engine operated by hot air has received very little improvement in design or construction for a good many years, the great difficulty being that air is a very poor conductor of heat. By heating the air from below, however, the designer of the Svea engine has accomplished a result which it is believed is of considerable importance in this connection. A volume of cool air split up into thin sheets passes over heated plates at a predetermined velocity, and absorbs the heat radiated from these plates. An engine of 6 horsepower applicable to launches and automobiles is being put on the market by the Svea Caloric Engine Company, of 119 Nassau street, New York. It has a cylinder measuring 4 1-4 inches by 4 7-8 inches stroke, and makes 450 revolutions per minute. The heater is 20 inches in diameter and 16 inches long, with a heating surface of 60 square feet. The apparatus is applicable to the use of air, steam, or any other gas of similar character.

The Bard Adjustable Bushing.

Made by the Armstrong Manufacturing Company, of Bridgeport, Conn., this bushing has some new features which will recommend it at once to all users of bushings, as well as to the trade in general. It is fitted with hardened jaws which are moved to and from center by means of a cam plate, and by fastening the plate with the thumb screw the jaws are firmly held in any desired position. The adjustable jaws make a perfect center for the pipe



or rod, fit closely around the same, and insure the cutting of a straight thread. When necessary a crooked or drunken thread can be cut with this bushing as easily as with a ring bushing. When once attached to the die stock it can always remain there. It does away with the necessity of carrying a number of loose ring bushings, and saves the time now lost in hunting for and changing the bushing for each size of pipe.



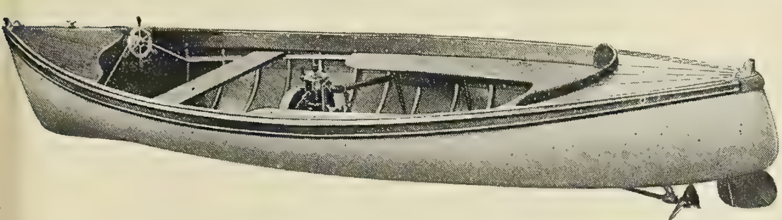
The McGrath Pneumatic Flue Welder.

The McGrath pneumatic flue welder, illustrated herewith, is made by the Draper Manufacturing Company, of Port Huron, Mich. It was designed to expedite and cheapen the welding and swaging of boiler flues, and is adapted for all sizes of flues up to a diameter of 4 1-2 inches. The cut shows the machine with one side set up for scarfing 2-inch flues, and the other for welding them.

The machine consists of a double-cylinder pneumatic hammer set on a base, and taking up a floor space of less than two feet square, and about 4 1-2 feet high. The frame and double cylinder are a single steel casting. The piston, which is made of hardened tool steel, ground to fit, has a diameter of 3 1-16 inches. At its lower end it is attached to the top die, being held in place by a key. The lower die is held rigidly in the steel frame. Air is admitted through a 3-4-inch pipe connected through the back of the valve box inside of the base. This valve box has two independent valves, connecting with a foot lever. Each side of the machine works independently, so that while welding is being done, the side used for scarfing is idle, and *vice versa*.

A New Power Dinghy.

This little boat is placed on the market by the W. H. Mullins Company, of Salem, Ohio, and is constructed of steel. The length of the one we illustrate is 16 feet, with a beam of 50 inches, a depth amidships of 21 inches, and a weight in running order of 350 pounds. The ribs, keel, stern, and bow post are of white oak, except that the ribs under the engine are of steel channels. The hull is made of galvanized steel covered with



aluminum paint. The engine consists in a reversible two-cycle motor with one cylinder operating a solid bronze propeller, and has a capacity of 1 1-2 horsepower, giving the boat a speed of a little under six miles per hour; with a 3-horsepower engine the speed is about 7 1-2 miles. It forms an excellent little yacht tender.

TECHNICAL PUBLICATIONS.

Practical Perspective. By Frank Richards and Fred. H. Colvin. Pages 56; illustrations 62. New York: The Derry-Collard Company, 1905. Price 50 cents; with two pads of isometric paper $1.00.

This book starts out with the most elementary principles of isometric perspective, and deals in the first part, which is from the pen of Mr. Richards, with the perspective representation of figures containing all dimensions in full proportionate size. The second part of the book is devoted to the use of isometric paper, a sample of which is bound in near the front cover. This paper, which is of the same general order as the familiar cross-section paper of engineering work, contains horizontal and vertical lines, as well as lines at an angle of 60 degrees with the vertical, and inclined both to the right and to the left. The use of this paper very greatly simplifies the production of drawings in isometric perspective, as is shown by the numerous examples given in the form of illustrations.

Beeson's Marine Directory of the Northwestern Lakes. Pages 272; illustrations 65. Chicago: 1905, Harvey C. Beeson, publisher, 341 to 351 Dearborn street. Price $5.00.

This is the nineteenth annual appearance of Beeson's Marine Directory, and, as in preceding years, it consists in a very complete directory of the steam vessels of the Lakes, the sailing vessels, the Canadian steamers and sailing vessels; and under separate headings are lists of the iron-ore carriers, the lumber vessels, and particulars of the machinery and boilers of all steam vessels on the Great Lakes. A large number of illustrations has been used, almost all being half-tones; they represent not only Lake ships, but ships on the coast, pleasure craft, ocean yachts, as well as buildings and views along the Sault Ste. Marie canal, it being intended as a sort of souvenir of the fiftieth anniversary of the opening of that canal, which occurred in June, 1855. Mention is made in the introduction of the tremendous progress in Lake navigation during the fifty years in question, from the first shipment of twelve barrels of iron ore to the present-day cargoes of nine and ten thousand tons each, and annual shipments of over twenty million tons.

QUERIES AND ANSWERS.

All reasonable questions concerning marine engineering received from and signed by subscribers will be answered by the Editor in this column. All communications must bear the name and address of the writer.

Q. 296.—Do sea tugs, like *Gypsum King*, average, when towing, over nine knots, and about how many tons do they burn in twenty-four hours when towing? Is she not the most powerful tug afloat (excepting the *Astral*) which burns oil if I am not mistaken?

I am designing a sea tug very much like *Gypsum King*, and I want to know just how large the dimensions of boiler and engines should be and where they should be placed? W. J. E. and J. L. D.

A.—We are informed by the J. B. King Plaster Company, who own and operate the tug *Gypsum King*, that with a load in tow of 6,500 tons an average of 6 1-2 knots is maintained, the speed, light, being about 15 knots, and we believe that this tug is capable of maintaining a speed of 9 knots with about 4,000 tons in tow. The coal consumption has been given us as from 12 to 14 tons per day when running at full power.

This tug has been very completely covered by a description in MARINE ENGINEERING, at page 116, for September, 1899. This gives the positions of machinery together with dimensions of the same. We might state, however, that the engine is of the triple-expansion type with cylinders 17, 27, and 45 inches in diameter by a stroke of 36 inches, while each of the two single-end boilers has a diameter of 13 feet and a length of 11 feet 2 inches.

Q. 297.—Be so kind as to answer the following in your Queries and Answers column:

Given a triple expansion marine engine to develop 1,900 I. H. P.; R. P. M. 90; W. P. = 185 lbs. (Howden forced draft), for a merchant steamer 5,000 tons displacement, 12 knot speed.

(*a*) Please show method to determine the economical speed for this vessel.

(*b*) How boiler pressure must be reduced for this purpose.

(*c*) How will it change the efficiency of the engine if the cut-off (0.57) in H. P. C. remains the same? I mean will it change the factor f in the formula $p_m = f\left[p\,\frac{(1 + \text{hypolog}\,r)}{r} - p_b\right]$ or not?

It may be assumed that the back pressure in the condenser p_b is equal to 4 pounds in every case, and $r = 11$.

The principal dimensions of engine are 25, 38 and 62 1-2 inches by 40 inches stroke. V. T.

A.—(*a*) The economical speed for a ship of the class mentioned is a factor not at all defined in the term above mentioned, as it might be from an engineering standpoint one thing, and from a commercial standpoint quite another. That is to say, from an engineering standpoint, a very low speed would be found to give the greatest number of miles per ton of coal burned, whereas from a commercial standpoint, when we take account of the fact that the ship is all the time under fixed charges, as interest on first cost and for deterioration, and, furthermore, that the officers and crew are drawing fixed salaries per month, it is seen that a low speed would increase all of these items per mile traveled by the ship, and that as a result the most economical speed would be considerably higher from a commercial standpoint than would be the case from the standpoint of the engineer alone. A determination of the correct value for this is practically out of the question from a theoretical basis, and can be obtained only by means of tests with the ship actually in service, and by computations from the results of these tests.

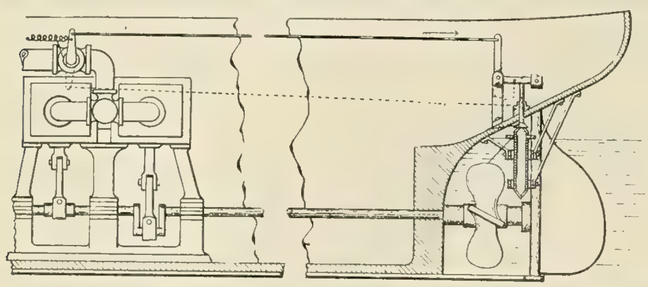
(*b*) If the speed determined upon as an economical one is below the best sea-speed of the ship, the boiler pressure will be reduced in order to decrease the number of revolutions per minute to such a point as to give the new speed. A determination as to how much of a reduction would be required may be made roughly by computing, first, the horsepower required to propel the ship at the new speed as compared with that for which the engines were designed, and then reducing the boiler pressure in approximately the ratio of the square root of the figure obtained by dividing the new horsepower by the old. This follows from the fact that the revolutions per minute will vary pretty closely with the steam pressure, and that the horsepower will vary as the product of the two.

(*c*) With the cut-off in the high-pressure cylinder remaining the same under the new conditions, the card factor, *f*, in the formula quoted, would remain about constant, and the mean effective pressure would be reduced in a slightly greater ratio than would the pressure at the engines, because of the fact that the subtractive item of back pressure is assumed to remain the same.

SELECTED MARINE PATENTS.

791,132. DEVICE FOR CONTROLLING THE MOTIVE POWER OF VESSELS. G. G. BOE, TORONTO, CAN.

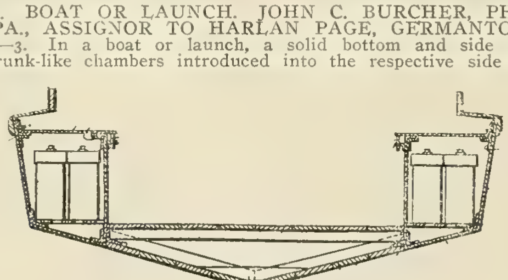
Claim.—1. In a device for controlling the motive power of vessels, a hanger attached to the stern part of the vessel, said hanger consisting of circular rings arranged one above the other, said rings having brace-arms extending therefrom and adapted to fasten to the said vessel, a cylindrical buoy encircled by the said rings, said buoy terminating in conical-shaped ends, a reciprocal rod extending through the said vessel, one end of said



rod engaging with the upper end of said buoy, and the other end engaging with mechanism adapted to open and close the throttle-valve of the motive power; means by which the said buoy is supported in the said rings. Four claims.

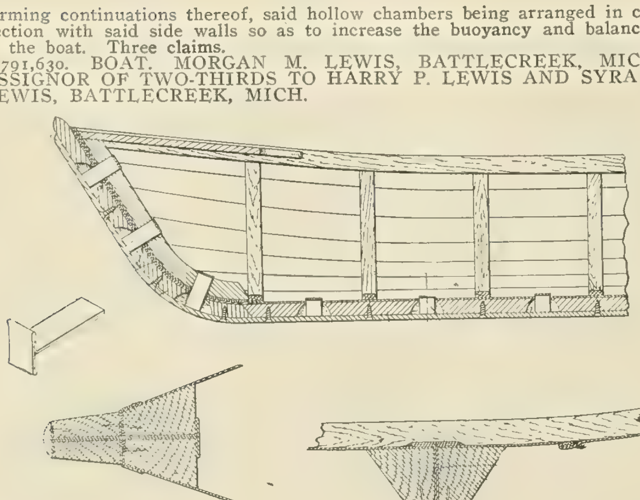
791,242. BOAT OR LAUNCH. JOHN C. BURCHER, PHILADELPHIA, PA., ASSIGNOR TO HARLAN PAGE, GERMANTOWN, PA.

Claim.—3. In a boat or launch, a solid bottom and side walls, and hollow trunk-like chambers introduced into the respective side walls and



forming continuations thereof, said hollow chambers being arranged in connection with said side walls so as to increase the buoyancy and balancing of the boat. Three claims.

791,630. BOAT. MORGAN M. LEWIS, BATTLECREEK, MICH., ASSIGNOR OF TWO-THIRDS TO HARRY P. LEWIS AND SYRA E. LEWIS, BATTLECREEK, MICH.



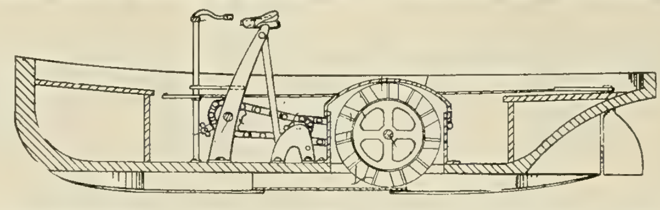
Abstract.—The objects of this invention are, first, to provide an improved boat having a sheet-metal skin or shell which is economical to produce and strong and durable; second, to provide in a boat having a sheet-metal skin or shell an improved keel and means for securing the same in position; third, to provide an improved boat having a sheet-metal skin in which packings or gaskets are dispensed with. Seven claims.

792,121. STEERING DEVICE FOR POWER-BOATS. JAMES J. DONOVAN, PEABODY, MASS.

Claim.—1. The herein-described steering device, consisting of a wheel-carrying spindle, a pinion attached thereto, a longitudinally-movable rack-rod actuated by the pinion, a guide-sleeve in which said rack-rod is movable, means for adjustably securing said sleeve and means for adjustably securing the spindle and pinion in the required position. One claim.

792,687. MARINE PROPULSION. KNUD O. WOLL, NEAR TACOMA, WASH.

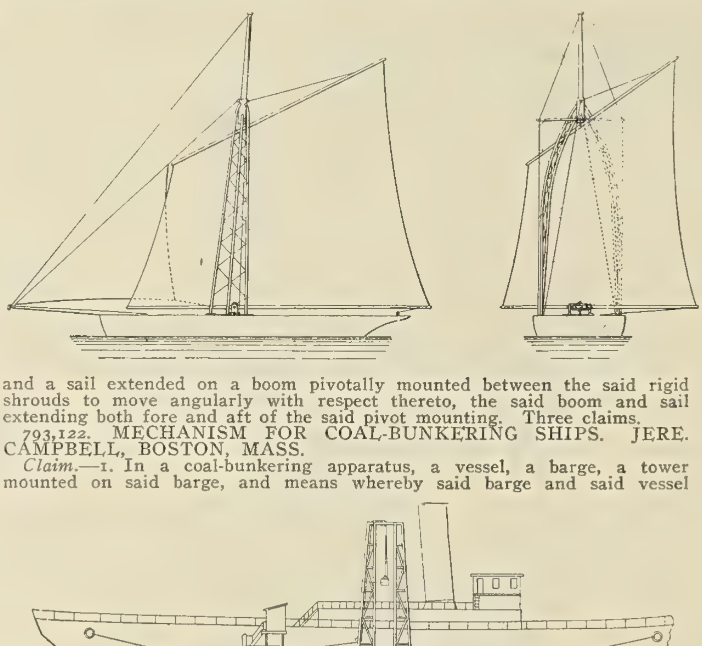
Claim.—In a marine propeller, the combination with a vessel having a central hole in the bottom thereof, a propeller-box within said vessel and being open at the bottom and covering said hole, a paddle-propeller journaled in said box and passing through said hole and below the vessel, a watercourse-box secured to the bottom of said vessel and open at its ends



said watercourse-box extending forward of said hole in the vessel and being widest at its forward end, and a pedal-actuated set of sprocket-wheels and chains whereby said paddle-wheel may be rotated in said propeller-box. One claim.

792,924. SAIL FOR VESSELS. GEO. E. POSGATE, GRAVESEND, ENGLAND.

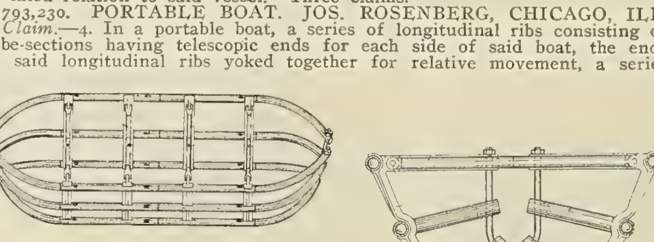
Claim.—3. A single-masted fore-and-aft rigged vessel having a mast consisting of rigid shrouds extending upwardly and inwardly from either side and rigidly attached thereto, and also to each other at their upper ends,



and a sail extended on a boom pivotally mounted between the said rigid shrouds to move angularly with respect thereto, the said boom and sail extending both fore and aft of the said pivot mounting. Three claims.

793,122. MECHANISM FOR COAL-BUNKERING SHIPS. JERE. CAMPBELL, BOSTON, MASS.

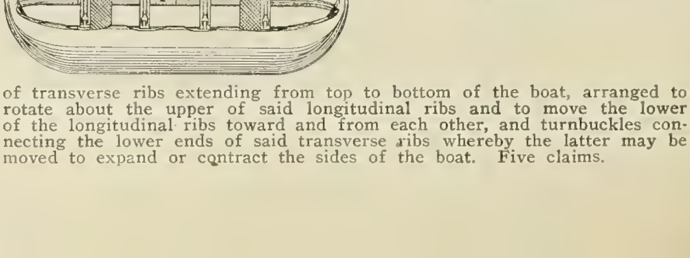
Claim.—1. In a coal-bunkering apparatus, a vessel, a barge, a tower mounted on said barge, and means whereby said barge and said vessel



may be moved with relation to each other while said tower is maintained in fixed relation to said vessel. Three claims.

793,230. PORTABLE BOAT. JOS. ROSENBERG, CHICAGO, ILL.

Claim.—4. In a portable boat, a series of longitudinal ribs consisting of tube-sections having telescopic ends for each side of said boat, the ends of said longitudinal ribs yoked together for relative movement, a series



of transverse ribs extending from top to bottom of the boat, arranged to rotate about the upper of said longitudinal ribs and to move the lower of the longitudinal ribs toward and from each other, and turnbuckles connecting the lower ends of said transverse ribs whereby the latter may be moved to expand or contract the sides of the boat. Five claims.

Marine Engineering

SEPTEMBER, 1905

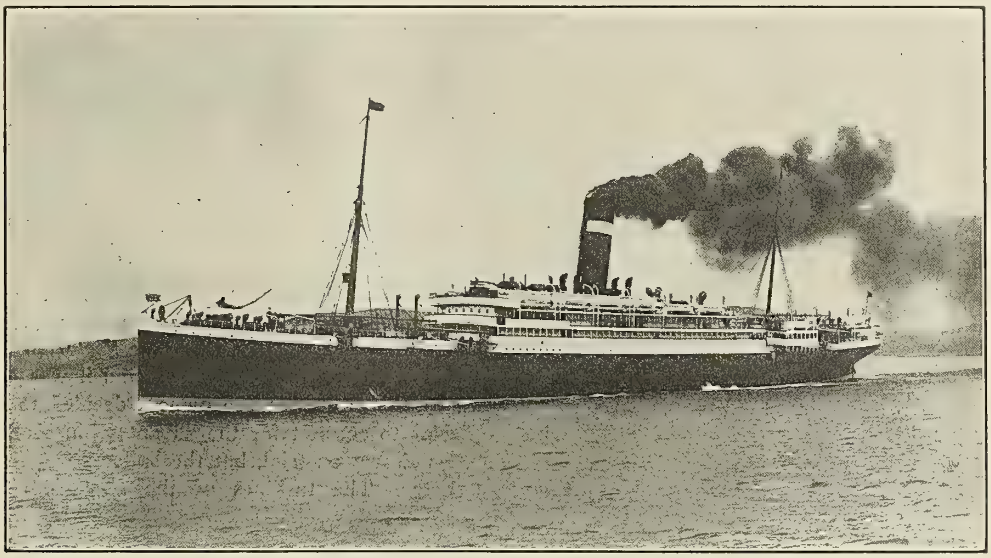
THE ALLAN LINE TURBINE STEAMERS VICTORIAN AND VIRGINIAN.

BY BENJAMIN TAYLOR.

The Allan liner *Victorian*, the first turbine steamer for the regular Atlantic service, was built by Messrs. Workman, Clark and Company, of Belfast. Messrs. J. & A. Allan, of Glasgow, were thus the first to venture into the comparatively unknown. So confident were they of the fitness of the turbine for the cross-Atlantic trade that they at the same time ordered a sister ship, the *Virginian*, both of which are now in service between Liverpool and Montreal.

The *Victorian* is a triple-screw turbine steamer of 10,630 tons gross. She is 540 feet in length, 60 feet in breadth, 42 feet 6 inches in depth, and has accommodation of the best class for 1,300 passengers. She is divided into eleven compartments, and these, together with the sub-divisions of the double bottom, give her twenty distinct watertight spaces. She has been constructed to the highest class of the British Corporation registry, and the strength of the hull has been specially augmented beyond the requirements of that society to meet the heavy swell of the North Atlantic. First-class accommodation is provided in houses situated on the bridge and promenade decks, and the distance between decks has been made higher than usual in order to allow of state rooms to accommodate two and three persons, and also for a number of suites. The dining saloons for the first-class are placed one at the fore end of the bridge, with seating accommodation for 200 persons, and another at the after end of the bridge, with similar accommodation. On the main deck is the second-class saloon. The first-class music room, library, and writing rooms are at the fore end of the upper bridge, immediately above the forward dining saloon. The smoke room is a large oak-paneled apartment at the after end of the promenade deck. Second-class passengers are accommodated in four-berth rooms on the upper and main decks amidships. The third-class accommodation is arranged in the upper and lower 'tween decks, in four-, five-, and six-berth cabins. Dining saloons, sitting room, music room and smoke rooms have also been provided for the third-class passengers. Special features are ample space, perfect ventilation, and liberal use of the latest ideas of comfort.

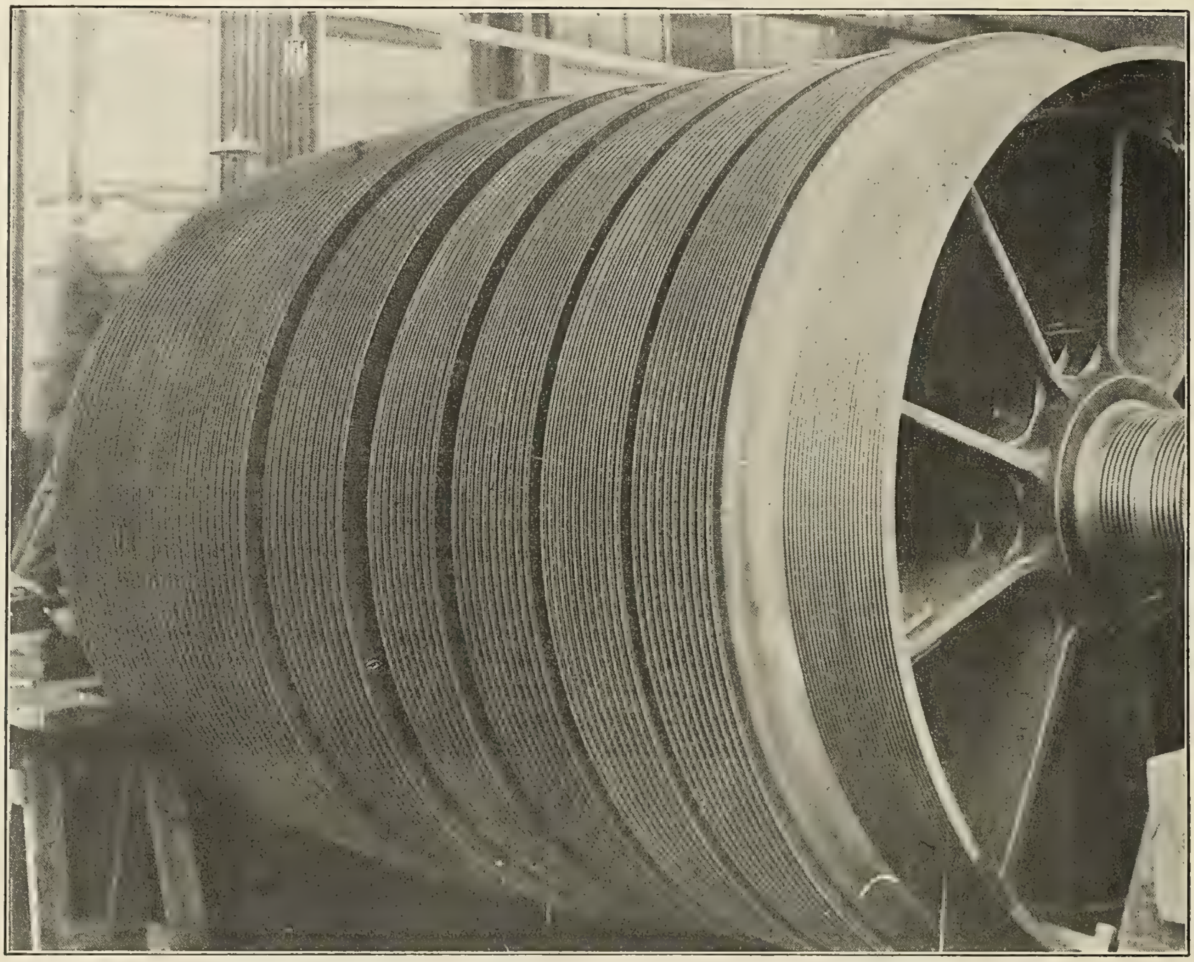
The *Victorian* has space available for about 8,000 tons of cargo, and the facilities for its rapid handling and discharge are of the most efficient kind. Special attention has been given to the arrangement of the cargo holds. The ordinary round pillar supports for the decks have been discarded in favor of special girders and struts, which leave the holds freer for the handling of cargo Insulated chambers for the carriage of fruit and dairy produce are provided, in conjunction with refrigerating plant on the cold-air circulation system.



ROYAL MAIL STEAMSHIP VIRGINIAN.

The machinery consists of three Parsons turbines operating separate shafts, each carrying one propeller. The center turbine is high-pressure and each of the two outside turbines low-pressure, and there is a special arrangement, devised by Mr. Parsons, whereby reversing power almost equal to the forward propelling power can be imparted to the low-pressure turbines. The *Victorian* is designed in this way to surpass the ordinary twin-screw steamer. The arrangement of the propellers, and the rapidity with which power can be directed on each of the outer shafts separately in either direction, give the vessel great maneuvering ability.

The second steamer, *Virginian*, which was built on the Clyde by Messrs. Alexander Stephen & Sons, of Glasgow, is a sister ship to the *Victorian*, but the boats are not exactly alike. They are of the same general dimensions, and they are built to the same



THE ROTOR OF ONE OF THE TURBINES, SHOWING THE 750,000 BLADES OR VANES.

coefficient, but the Allan Company allowed the builders scope for showing their individual ability. The relation of the horsepower of the boilers to the engines is not quite the same in both, so that the results may throw some further light on the efficiency of turbine machinery. A notable difference to the onlooker is in the funnels. The *Victorian's* is oval, while that of the *Virginian* is round.

The *Virginian* ran trials on the Firth of Clyde just about the time the *Victorian* was due to arrive at Halifax on her first voyage across the Atlantic. The *Virginian* was designed from the first for turbine machinery, while the *Victorian* was intended originally to have reciprocating engines, and it was only after the hull was partially built that the owners decided to install turbines. This helps to account for the advantage in speed which the *Virginian* has shown on trial, but the boiler power of the vessels is also a factor. The turbines of the *Victorian* were supplied by the

MUSIC ROOM ON VICTORIAN.

DINING SALOON ON VICTORIAN.

THE TURBINE STEAMSHIP VICTORIAN.

builders, while those of the *Virginian* were supplied by the Parsons Company. The *Victorian* on her trials on the Clyde did 19½ knots with the engines running 260 revolutions and indicating about 12,000 horsepower, while the *Virginian* made 19.8 knots with engines running 280 revolutions and indicating about 12,500 horsepower. The horsepower is approximate, but the figures estimate as nearly as possible the power that would have been developed by reciprocating engines driving the same vessels at the same speed and under the same conditions. The original speed aimed at was only 17 knots, so the vessel has more than realized expectations. The almost entire absence of vibration was specially noted by those on board. She was absolutely motionless at all speeds, except quite near to the stern, where there was a slight tremor from the dynamos and the propellers, so slight that it was hardly noticeable.

Further difference exists between the *Victorian* and the *Virginian* in the passengers' quarters. The first-class saloon of the *Virginian* is a square apartment, decorated in Georgian style with mahogany paneling, and with a large number of small tables suitable for parties. The floor is laid in oak parquetry. The beam casing of the ceiling is in polished hardwood, and the panels are decorated with lincrusta. The dome is paneled in hardwood with an alcove all round filled in with fibrous plaster sea figures decorated with electric lamps, and having an ornamental brass grille. The music room is paneled and finished in enameled wood and waxed mahogany, with ornamental panels of silk tapestry. The saloon and the music room have each a fine, open fireplace, which is not the case on the *Victorian*. The special suites of rooms consist each of a bedroom and a state room, while some of them have also a bath room. The walls of these rooms are paneled with silk. Each suite is different from the others, there being green rooms, blue rooms, and red rooms. One feature of the suites is that each may, if desired, be taken by one passenger, in which case one of the two beds folds away out of sight. The library and writing room, smoking room, and nursery are specially fitted up in artistic and comfortable manner.

FIRST-CABIN SMOKING ROOM.

The Position of Warrant Machinist; His Duties, and Opportunities in the Navy.

BY W. M., U. S. N.

It is a common thing for brothers in the engineering profession in civil life to ask: "What kind of a position do warrant machinists occupy in the Navy? What are the requirements? To what engineer officer are warrant machinists responsible? What are the duties, pay, etc.?"

The advent of the warrant machinist came with the navy reorganization bill of 1899, which abolished the engineer corps by consolidation with "the line." The same bill authorized the appointment of 100 warrant machinists, which number has since been increased to 180, but is still only about one-half that equal to the demand. Owing to this scarcity, none have been available for gunboats or destroyers.

The following extracts from the Navy Regulations will give a fair idea of the qualifications:

"Vacancies in the list of warrant machinists shall be filled by competitive examination before a board ordered by the Secretary of the Navy, and open to all machinists in the Navy, and machinists of good character, not above thirty years of age, in civil life, authorized by the Secretary of the Navy to appear before the board.

"With applications from machinists in the Navy there must be statements of opinion of the commanding officer and engineer officer under whom the applicant is serving. These opinions will be limited to the question of whether the applicant is regarded as qualified for the position of warrant machinist and worthy of such advancement.

"Applicants from civil life must furnish testimonials of good moral character and correct habits, and certificates showing experience in machine shop, and in the engine room of a steamer. . . . No applicant from civil life will be examined who is not a machinist by trade, and has not had the care and management of the steam machinery of a sea-going vessel in regular service."

These examinations, which are held annually in September, embrace a general knowledge of the engineering business, such as is gained by all practical engineers through their trade as a machinist, their earlier experience at sea, and probably through the use of a considerable quantity of "midnight oil" applied as a lubricant to the mental wearing surfaces.

SEA DUTIES.

The regulations specify the following duties for warrant machinists:

"They shall act as assistants to the engineer officers of the ship in all that relates to the care and maintenance of the machinery, boilers, and appurtenances; and shall perform such duty as may be assigned them.

"They shall stand regular watches, in not more than four watches. Routine duties in connection with the surveillance, care, and efficient condition of the machinery, boilers, and mechanical appliances will be assigned them by the senior engineer officer."

The watch duty of the warrant machinist is similar to the usual duties of the assistant engineer in the mercantile marine, but possibly the former has a larger sphere of duty. Having responsible subordinate machinists in charge of each main engine, his presence is not constantly required at the throttle, which permits him to exercise more oversight throughout the department. He is required to be at the engines, however, at all times when they are being operated upon entering or leaving port. The engine-room watch in warships of the first and second class consists of one warrant machinist, one machinist in charge of each engine, two oilers in each engine room, one store keeper, and one coal passer detailed as messenger. In vessels having four warrant machinists their watches are "dogged" every evening, thus avoiding that fatiguing experience of having the "mid-watch" for a week.

The care, maintenance, and repair of the machinery in warships is apportioned among the warrant machinists as follows:

Senior in rank, starboard engine room and contents. Second in rank, port engine room and contents. Third in rank, fire rooms and contents. Junior, all auxiliary machinery outside of engine and fire rooms, including steam launches, distilling and refrigerating plants, winches, etc.

In port warrant machinists perform "day's duty." The tour of duty begins at 8:00 A.M. and continues for twenty-four hours, though it is permissible to "turn in" from 9:00 P.M. to 5 A.M., but subject to call at any time. During the day the officer on duty is responsible for the execution of all orders and carrying out of all work in the department, though he may be relieved from many details by reason of such details coming under the direct responsibility of the other warrant machinists to whose "station" the work belongs. He carefully records in his log all work performed during his "day's duty," which is finished the following morning by carrying out the morning routine work from 5:00 to 8:00 A.M.

With four efficient warrant machinists, the practical engineering duties can be well performed without overtaxing that patience and endurance so essential to the faithful performance of engineering work, especially in tropical climates.

The senior engineer officer to whom warrant machinists are responsible is usually a lieutenant commander or lieutenant; a brilliant and refined type of gentlemen, and mostly a discreet and considerate officer. In battleships and large cruisers he is usually assisted by one lieutenant or ensign. Neither of these officers stands sea watch; each confines his duties to the more scientific engineering problems, the surveillance of the engineer's division, and general direction of the engineering department. As a general thing the warrant machinists are allowed the freedom of their own ideas in pursuing the mechanical methods which practice has proclaimed most successful to the practical engineer.

SHORE DUTY.

It is an unwritten rule in the Navy, in time of peace, that three years' sea duty constitutes a "cruise," after which officers are assigned to shore duty for such period as the exigencies of the service will permit. This period is usually about two years, in the case of most warrant officers, which is an agreeable relaxation from life on board ship. On shore, warrant machinists are assigned as assistants to the engineering officers at navy yards, where their duties consist of detail work in connection with vessels building or under repair. They are also assigned as assistants to the naval inspectors at private shipyards where war vessels are under construction; and they act as assistants to the inspectors of material at various places where naval material is manufactured.

Unfortunately, however, owing to the limited number of warrant machinists in proportion to the demand for their services at sea, they have not enjoyed as much shore duty as other warrant officers. It is hoped steps will soon be taken to remedy this defect through proper legislation. At present the increase is limited by law to twenty appointments yearly. This fact, combined with the knowledge that warrant machinists obtain comparatively little shore duty, tends greatly to retard the healthy growth of the corps.

PROMOTION.

1. Boatswains, gunners, and warrant machinists having four years' service as warrant officers, and being under thirty-five years of age, are eligible for promotion to ensign, and are then in line of promotion to highest rank.

2. All warrant officers (except warrant machinists, for whom it is hoped the law will provide at an early date) are, after six years' service as warrant officers, eligible for commission as "chief" in their respective grades, "to rank with, but after, ensign."

The examination for ensign embraces navigation, seamanship, ordnance, and steam engineering, and is not beyond the attainment of one having a good common-school education who becomes a warrant officer under thirty years of age. Of ten warrant officers who successfully passed this examination in 1904, three were machinists.

Promotion to "chief" grade is made upon physical and moral fitness; a satisfactory showing in the efficiency reports during the previous six years; and upon passing an examination in a few subjects in which much care, judgment, and responsibility are involved. This promotion carries the distinction of a commission, and the pay of an ensign, but "does not include additional right to quarters, nor to command." Its main advantage is the increase of pay after reaching the maximum, which is shown as follows:

Highest sea pay of chief grade	$1,960
" " " " warrant officer, with ration	1,908
Increase	$52

Highest shore pay of chief grade, with allowance	$2,248
" " " " warrant officer, with allowance	1,888
Increase	$360

PAY.

The sea pay of warrant machinists ranges from $1,200 to $1,800 per year, depending at date of appointment upon whether appointed from civil life, or from the Navy, with previous service. Those appointed from the Navy advance as follows: after three years' service, $1,300; six years, $1,400; nine years' service, $1,600; twelve years' service, $1,800; or maximum pay of warrant officers. Those appointed from civil life are credited by law "at date of appointment, for computing their pay, with five years' service." Thus it will be seen that a warrant machinist appointed from civil life enters on $1,300 per year, and one year later is advanced to $1,400; four years later to $1,600; and seven years later to $1,800. To the yearly sea pay at all times may be added $108 extra allowed for rations. Shore pay is about 10 percent less than sea pay, but the "allowance" is greater on shore than "rations" at sea.

When "incapacitated for the further performance of duty at sea," officers are retired on three-fourths of their sea pay; and at the age of sixty-two, all officers retire on three-fourths pay.

The position of warrant machinist in our Navy corresponds to that of artificer engineer in the British Navy. The latter, however, obtain recognition of their engineering ability through a suitable title, and are also in line of promotion to engineer ensign, engineer lieutenant, etc. The artificer engineer corps in that navy consists of about 300 officers, and so successful have they proved that the British Admiralty has provided for an increase to 800.

An English writer quoted in Consular Reports says: "The highest ambition of those who aim at speed is to exceed a speed in knots greater than the square root and a quarter of the vessel's length. The Atlantic liners cannot do it; motor boats and the torpedo-boat destroyer can, but such speed is attainable only at enormous extravagance."

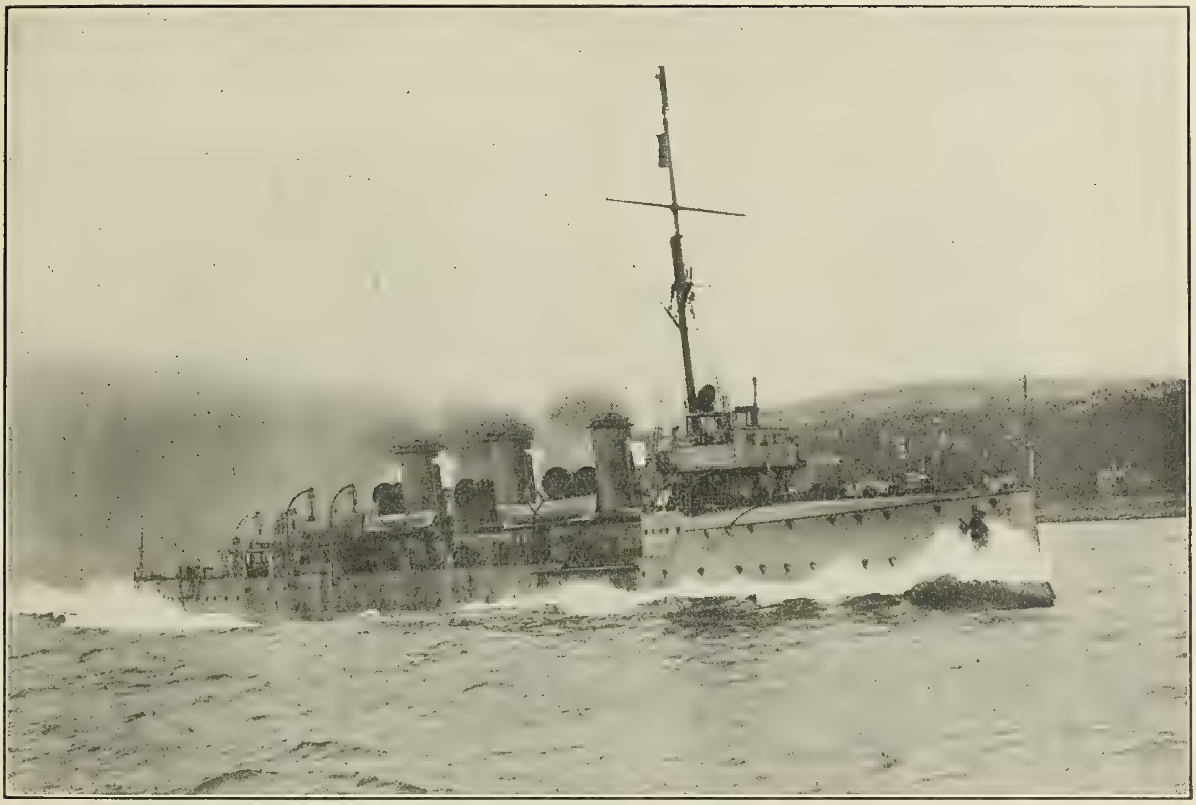
England has 31 ocean steamers of more than 12,000 gross tons each; Germany has 14, the United States 6, Holland 3, France 1, and Belgium 1. The total tonnage of these 56 ships is 840,521.—*Iron Age.*

THE ENGLISH SCOUT-CRUISER SENTINEL.

BY EMILE GUARINI.

The *Sentinel,* illustrated herewith, and designed, built, engined, and armed by Vickers Sons & Maxim, Ltd., is the first of the new scouts built for the British Navy. The scouts are armed with ten 12-pounder and eight 3-pounder guns, and have two tubes on deck for firing the larger size of torpedoes. A destroyer could not, therefore, stand up against such a ship, and the scouts will always have speed to run away from a formidable enemy. Speed, therefore, is the primary requirement in these craft, and when 25 knots was suggested it was arranged that this should be maintained under adverse weather conditions. This, therefore, necessitated ships of good sea-keeping qualities, and the performance of the *Sentinel* on her series of trials has proved that this ship meets this as well as other essential conditions.

In fact, it can be said that no ship has had to undergo a more searching test than that involved by the eight hours' trial at full speed. It is true that a run of similar duration is prescribed for battleships and cruisers, but in their case there is not the same limitation in regard to weight. In a battleship the units of power of the engines, as a rule, are about equal to tons of displacement; in cruisers the ratio is seldom more than 1¾ indicated horsepower to 1 ton; but in the scouts, typified by the *Sentinel,* the power is equal to 5¾ indicated horsepower per ton, even including in tonnage all the coal, ammunition, and stores for war service; so that it will be realized that the maintenance of such a high speed as 25 knots at sea for eight hours is a particularly severe condition. This speed, however, was easily exceeded, the actual average rate being 25¼ knots, which has never before been reached by any vessel larger than torpedo craft; and, moreover, it is said to be attained without any alteration either in the trim of the ship, in the form or pitch of propeller, or in the machinery arranged for in the design.



THE SENTINEL MAKING 25¼ KNOTS ON TRIAL TRIP.

The *Sentinel* is a vessel of 340 feet in length and 2,920 tons displacement; she has a high forecastle, to meet heavy seas, but otherwise lies low in the water, so that she will not be seen from the deck of the enemy's ship beyond eight miles radius. At the same time she has a very high bridge, higher almost than the three funnels, so that a good lookout may be kept. She is well divided by bulkheads, and the scantlings are much heavier than is usual in such high-speed craft.

The trials prescribed by the Admiralty were that the vessel should steam for 96 hours at cruising speed, and that the rate of coal consumption on the latter half of this run should determine the quantity of fuel to be carried when the vessel was running at full speed to enable her to travel 1,500 miles. With this allowance of coal and a load equivalent to the prescribed weight of ammunition, etc., the vessel was required to steam for eight hours at 25-knots speed.

THE SENTINEL ENTERING THE WATER.

At the beginning of this trial the vessel had to steam six times over the measured mile within a period of one hour and a half, and the average revolutions per minute made by the machinery during this time had to be maintained for the remainder of the eight hours. This insured that the speed throughout the whole of the eight hours would be 25 knots.

The first official test was carried out under very severe weather conditions, a gale blowing for three-fourths of the time, so that the vessel was well tested so far as seaworthiness was concerned, and the naval officers in charge spoke well of her behavior. The most important point of the trial had reference to the coal endurance, and it was found that the consumption per knot was practically 2 cwt. One ton was sufficient to carry the ship for 11 sea miles. This determined the load of coal which had to be carried on the full-power trial as about 140 tons.

Two preliminary runs were made over the measured mile, and everything being in order the official trial began. The first procedure was to make six runs over the measured mile at Skelmorlie. The first and second runs were made at low water with a slack tide, and it is suggestive alike of the precision with which the results were taken and of the regular working of the engines that the difference in time between the two runs was only six-tenths of a second. On the subsequent runs tidal influence came in, but the third and fifth runs, which were made against the tide, differed in time by only four-tenths of a second, while the two runs with the tide were made in exactly the same time, viz., 2 minutes 24.4 seconds. This meant practically no variation in engine revolutions, the mean power being about 17,500, while the mean of mean speeds was 25¼ knots. In conformity with the contract the vessel then proceeded down the Firth, the engines maintaining for a further 6½ hours the same number of revolutions.

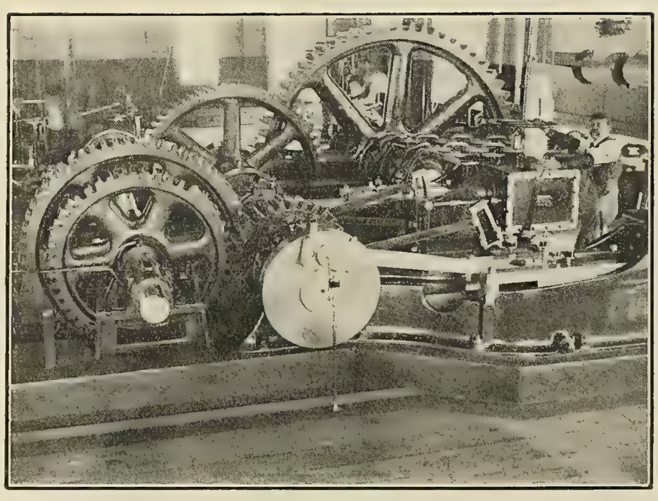
The Southern Pacific Company in Marine Work.

BY W. H. CRAWFORD AND T. B. BURNITE.

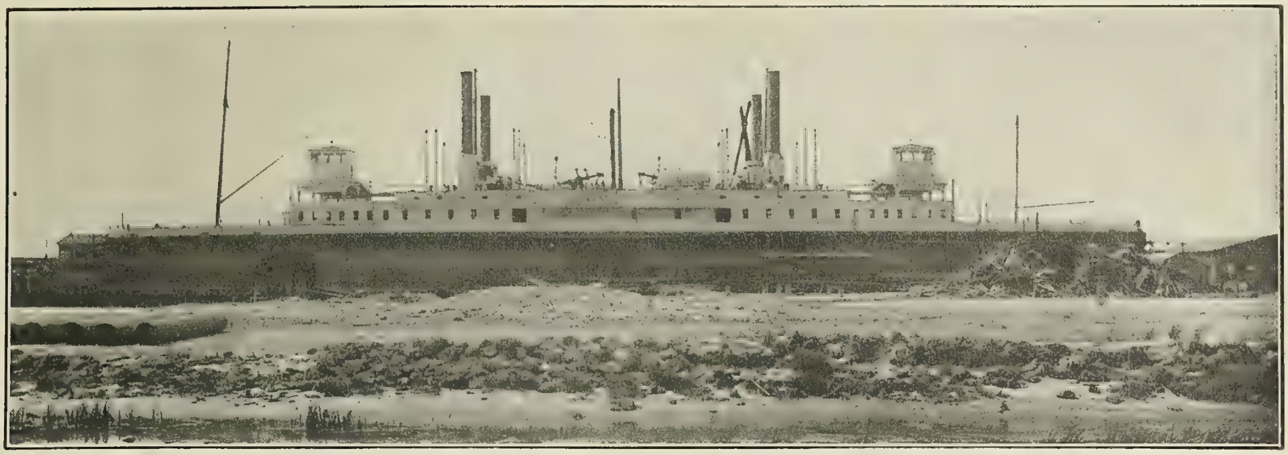
The waters of San Francisco Bay have come prominently before the public during the last few years in many ways. Attention was particularly drawn toward the metropolis of the Pacific Coast when the United States government began operating a regular line of transports between San Francisco and the Philippine Islands. The great opportunity for interesting development in marine matters is now at hand, on account of the immense population that is centering on the shores of this bay within a radius of ten miles from San Francisco, and in every direction.

There are already five separate companies operating large ferry steamers, the latest being the "Key Route." This company has just put into service its third boat, the *San Francisco*, which was fully described in the March number of Marine Engineering (page 111). The Southern Pacific Company is the oldest line, and it is with particular reference to one of the twelve large ferry steamers operated by this company that attention is now called—to what is said to be the largest ferry steamer in the world. The majority of the boats of this company operate between Oakland, the rail terminus of the trans-continental line, and San Francisco, the actual terminus, lying 4 1-2 miles across an arm of the bay.

There is a gap in the rail line, however, about thirty miles east of Oakland, at the head of San Francisco Bay, where the waters of the Sacramento River make a formidable obstacle. When the trans-continental line was put through, it was decided to fill in this



THE HOISTING ENGINES.

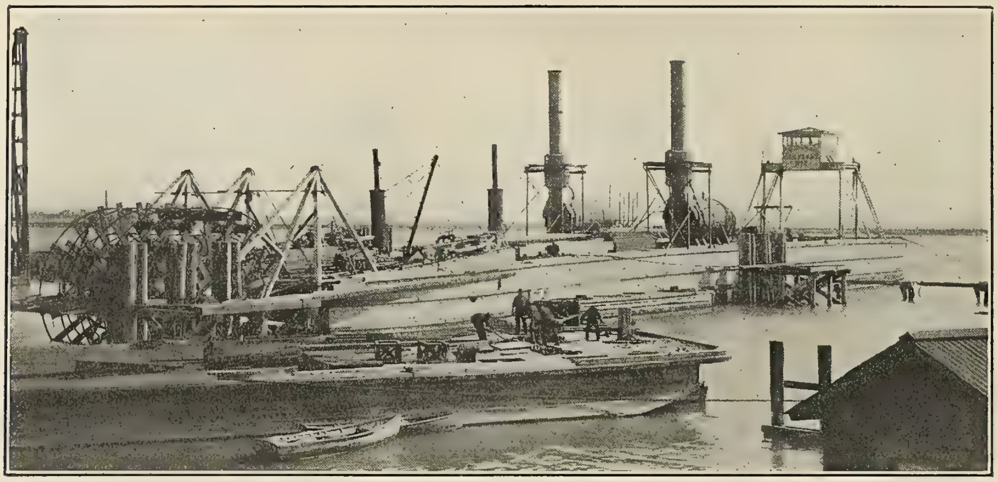


THE FERRYBOAT SOLANO ON SHORE ON THE MARINE RAILWAY.

gap by means of a train ferry, intervening between the opposite shores of what is known as Karquinez Strait. A large boat was designed and built, to transfer bodily all freight and passenger trains, over the mile of water. This was as long ago as 1879, but the boat which was then built at Oakland is still to-day in active service, and is a marvel in more ways than one. The *Solano* went into commission in that year on the one-mile course between Port Costa and Benicia, and has seen continuous service up to date, with the exception of a period of ninety days in 1895, when she was laid up to repair a damaged engine, and for a second period of eighty-two days, now just ended. That a boat of this size could be handled so successfully in the swift running current of Karquinez Strait without any damage save the trouble above referred to, which was the result of a broken piston rod, is a most wonderful record.

On February 5 of this year the *Solano* was taken out of the water and given a general overhauling, the principal item of which was a complete set of new boilers. When the Southern Pacific Company decided on the necessity for this work there was an unusual problem to contend with on account of the length of time required. The only available dry-dock for a boat of this size was so much in demand that its charges were prohibitive, and there was no marine railway on the coast of sufficient size to accommodate the *Solano*. After careful figuring the company decided to build a marine railway for this specific purpose, and ordered the complete railway from H. I. Crandall & Son, of Boston. It was completed, under the supervision of Superintendent McKenzie, at a total cost of about $115,000. One of the illustrations shows the powerful hoisting engines, which are capable of handling 4,000 gross tons, the dead weight of the *Solano*. The railway has an inclination of one-half inch per foot. The *Solano* was docked in forty-one minutes, without mishap of any kind. Two of our illustrations show bow and side views of the big boat as she appeared on the railway just before taking the water again on April 28, after the extensive repairs had been completed. The launching required twenty-one minutes.

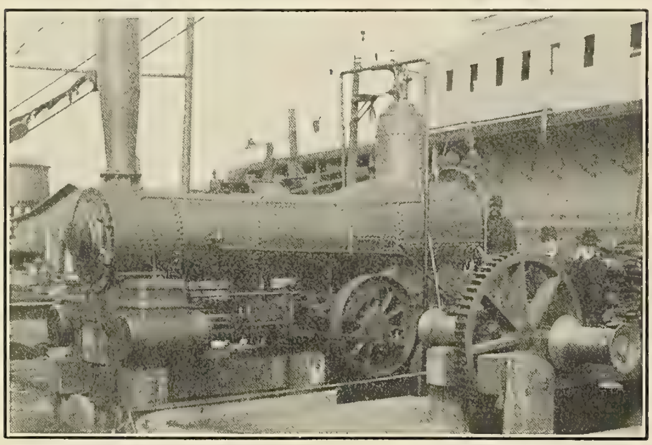
BOW VIEW OF THE SOLANO ON MARINE RAILWAY.



CAR FLOAT NUMBER TWO.

The *Solano* is 450 feet long; 65 feet beam; 116 feet extreme width over guards; 17 feet 8 inches depth of hull; 3,549 gross tonnage; 3,057 net tonnage; and the load draft is 8 feet. The two beam engines which drive the boat are located by the illustration, one operating each paddle wheel. They can be operated independently, this being an absolute necessity on account of the great weight and size of the boat, and the swift currents flowing across her course, which sometimes reach five miles per hour.

The engines, which were built by the Harlan and Hollingsworth Company, of Wilmington, Del., and operate under a pressure of 60 pounds, are of the vertical single-cylinder condensing type, each cylinder being 60 inches in diameter by 11 feet stroke. The indicated horsepower is 2,000. The paddle wheels are 28 feet in diameter with 16-foot buckets. Each shaft is 26 inches in diameter,



A LOCOMOTIVE HOISTING ENGINE.

and extends to the center of the boat, where it terminates in a half-crank, with wrist pin supported by crank and short shaft. This arrangement necessitates the placing of one wheel slightly in advance of the other, as each crank is on the center line of the boat. The stacks, four in number, extend 54 feet above the main deck.

Steam is supplied by eight boilers of the Scotch marine type, aggregating 2,000 horsepower. These boilers were built at the Southern Pacific shops at Sacramento, and are all equipped with oil burners. There is probably no better illustration of the advantages of fuel-oil burning than in the case of the *Solano,* where a saving in the monthly fuel bill of over 68 percent has been made over coal, with the latter at $2.80 per ton. The remarkable saving made with this boat is due largely to the character of service, and not so much to the low first cost of the oil. The distance from slip to slip being just one mile, the burners are lighted immediately before the boat pulls out, and shut off just before she reaches the opposite shore. There is thus no consumption of fuel save when the engines are actually running, and drawing on the boilers for steam.

The *Solano* regularly transports from thirty to forty-five cars and two or three locomotives at a time. The overland trains are placed on the boat and carried across the strait without any delay or inconvenience, many instances being on record where passengers have made the trip without knowing that they had left dry land.

During the present lay-up the *Solano* has received, besides her eight new boilers and other machinery, extensive overhauling to her wooden hull and all pipe work. Altogether about $120,000 has been expended, the first cost of the boat having been about $358,000. During the operations great speed was necessary in order to complete the work in the allotted time of ninety days. This rush has developed many ingenious appliances, among which is the hoisting engine shown by our illustration. This hoist is what is left of an old locomotive, which had seen service for about thirty years. A pinion was placed on the center of the main axle, engaging a large gear on a piece of line shaft about twenty feet long, and extending out beyond either side of the boiler. A second reduction of gears from this shaft supplied the winches with sufficient power to lift 200 tons.

A complete pneumatic tool plant was installed in connection with the marine railway, consisting of an air compressor and numerous drills and hammers, made by the Chicago Pneumatic Tool Company. On the *Solano* all of the spikes were driven with air tools, and the drilling was much simplified in the same way. It is said that the complete installation has paid for itself on this one job, having saved over $5,000 on the original estimate of cost for the work.

While this work has been going on the Southern Pacific Company has also been building a barge, which is the subject of another illustration, and is known as car float *No. 2*. It being necessary at present to transport great numbers of freight cars from the Oakland terminal to points around the bay, a number of car floats have been employed, these being operated by a fleet of steam tugs. It was decided to equip one of the car floats with engines and boilers of its own, and the installation is seen to be rapidly nearing completion.

It is a well-established fact that greater speed and economy can be attained by the new arrangement, both in actual running time, and in maneuvering at terminals. The main point of advantage, however, in these self-propelled boats, lies in the remarkably shallow load draft. Car float *No. 2* requires but 5 feet, which permits her to run safely along nearly any portion of the bay shore, where the tugs drawing 18 feet are at a disadvantage. San Francisco Bay is also subject, at times, to very rough weather, when ordinary tugs with cargoes in tow have difficulty in making headway. The new self-propelled car float will be better able to face a hard blow.

boilers, each having a diameter of 12 feet 7½ inches, and a length of 21 feet 5 inches; each contains two furnaces in each end, of a mean diameter of 46½ inches. The total grate surface is 83.5 square feet, and heating surface 3,498 square feet; this gives a ratio between the two of 41.9 to 1. The working pressure is 210 pounds.

THE LAUNCH OF THE SIENA, WITH STEAM UP.

The Launch of the Italian Twin-Screw Steamship Siena.

BY DAGNINO ATTILIO.

On April 29, the new ship *Siena,* for the transatlantic trade, was sent into the water by the Odero Shipbuilding Company. The *Siena* is of the spar-deck type and is rated 100 A1 by the Italian Register and the German Lloyds. She is fitted with both first cabin and third-class accommodations and has a considerable capacity for cargo. The *Siena* much resembles the *Toscana* and the *Ravenna,* which are in the Rio Plate service of the same line, and is rigged with two pole masts and one funnel. The midship deck house extends between the masts. The cargo hatches are near the masts in the "break" of the deck.

The first-class accommodations are located in the deck house amidships on the bridge and shelter decks, while the forward end of the boat deck, as well as the sides of the two decks next below, are set aside as a promenade. The accommodation has been worked out on an elaborate scale, with decoration largely in carved mahogany and white enamel finish, and the furniture in dining saloon, music room, and ladies' parlor is very rich. The capacity for first-class passengers numbers 80, while provision is made for 1,400 of the third class.

The ventilation has been carefully worked out with an idea of using natural ventilation wherever possible. Illumination is, as usual, by electricity, and very complete. The pantries and galley are amidships, and so arranged and ventilated as to offer the passengers no inconvenience even in tropical climates.

In connection with the hull, new features have been introduced in the shape of a stern post in three pieces riveted together, the upper and lower pieces being of forged steel and the middle piece of cast steel, the latter forming a solid body with the propeller-shaft brackets.

The ship has a length over all of 400 feet, a length between perpendiculars of 380 feet, an extreme beam of 46 feet 6 inches, a depth of 29 feet 6 inches, and displaces 8,050 tons. She is propelled by two triple-expansion engines with cylinders 19⅜, 32¾, and 55⅛ inches in diameter, and a common stroke of 39⅜ inches. The percentage of the stroke at which steam is cut off in the high-pressure cylinder is 75; intermediate, 68; and low, 64. With 85 revolutions per minute 3,000 horsepower is developed, this giving a speed of 14.5 knots. There are two double-ended Scotch boilers, each having a diameter of 12 feet 7½ inches, and a length of 21 feet 5 inches; each contains two furnaces in each end, of a mean diameter of 46½ inches. The total grate surface is 83.5 square feet, and heating surface 3,498 square feet; this gives a ratio between the two of 41.9 to 1. The working pressure is 210 pounds.

The propellers are four-bladed, with a diameter of 14 feet and a mean pitch of 17 feet 2 inches; this gives a pitch ratio of 1.23, while the projected surface is 48 square feet and the developed surface of each propeller 59.5 square feet. The crank shaft and pins have a diameter of 11 7/16 inches, while the line shaft is reduced to 10⅝ inches and the propeller shafting increased to 12⅜ inches. There are five thrust rings, giving a total of 760 square inches of thrust surface. The piston rods have a diameter of 5 5/16 inches, crosshead pins 5 11/16 inches, and connecting rods 5 5/16 inches. The latter measure 84⅝ inches between centers. The air pumps are of the Edwards type, with a diameter of 18½ inches and a stroke of 19¾ inches. The centrifugal circulating pump has a rotor diameter of 31½ inches, and is operated by an engine with

STERN OF THE SIENA ON THE WAYS.

cylinder measuring 6¾ by 6¾ inches. The feed pump measures 3⅛ by 19¾ inches. There are two main condensers, with cast-iron shells, having a total cooling surface of 1,938 square feet distributed over 572 tubes with a diameter of ¾ inch and a thickness represented by No. 17 B.W.G. The length between tube plates is 15 feet 5 inches.

ABSTRACT ENGINEER'S LOG, S. S. AUSTRALIA, VOYAGE NO. 3, BOUND WEST.

EASTBOUND...............	Leaving: New York............. ....I ....A M. .... P.M.	Passing Sandy Hook Lightship: ....I ......................................A.M. .....................................P.M.
WESTBOUND...............	Leaving: Southampton..............Feb. 13, 1905. .......................A.M. ....12.1 P.M.	Passing Needles: .... Feb. 13, 1905. ...................................A.M. .... 1.32 P.M.

	Dates.			Time.					Average Steam Pressures.							Vacuum.	
	Day of Week.	Month.	Day of Month.	Length of Day in Hours and Minutes.	Hours Steam Up.	Hours Steaming.			Boilers.	1st Receiver.		2d Receiver.		3d Receiver.		Condenser.	
										Port.	Stb'd.	Port.	Stb'd.	Port.	Stb'd.	Port.	Stb'd.
1	Tuesday.......	1905 February.	14th	24′ 53″	24′ 53″	19′ 48″	......	......	196	93	89	38	40	8	7	25	24¾
2	Wednesday.....		15th	24′ 51″	24′ 51″	24′ 51″	......	.....	202	95	91	40	42	8	8	25	25
3	Thursday..		16th	24′ 49″	24′ 49″	24′ 49″	......	......	200	95	90	38	42	8	8	25	25
4	Friday.........		17th	24′ 42″	24′ 42″	24′ 42″	......	......	196	93	90	38	41	8	8	25	25
5	Saturday........		18th	24′ 41″	24′ 41″	24′ 41″	......	......	200	94	90	39	42	8	9	25	25
6	Sunday.........		19th	24′ 43″	24′ 43″	24′ 43″	......	......	202	96	92	39	43	9	9	25	25
7	Monday		20th	21′ 39″	21′ 39″	15′ 01″	......	......	201	96	90	39	42	9	9	25	25½
8	......		....	....	....	....	......	......	...	..	..	..	..	..	..	..	..
9	......		....	....	....	....	......	......	...	..	..	..	..	..	..	..	..
10	.....		....	....	....	....	......	......	...	..	..	..	..	..	..	..	..
Totals and averages..................				170′ 18″	170′ 18″	158′ 35″	......	......	200	95	90	39	42	8	8	25	25

Summary of Coal Consumption.		
Remaining on board from passage...	....	410
Received on board at Southampton..................................	....	2,188
Total remaining and received......................................	....	2,598
Consumed in port..	180	
Coal used laying fires, raising steam, lying in river..............	56	236
Total on board, leaving..	....	2,362
Coal used between { New York and Sandy Hook.................	70	....
Coal used between { Needles and Southampton..................	15	. .
Consumed in main boilers on sea passage..................	1,807	....
Consumed for other purposes on passage.................... ...	15	1,907
Remaining on arrival at New York..................................	1,907	455
Kind of Coal..............	....	....
Quality...	....	....

Details of Coal Consumption.		
Consumed in port includes, below :		
Main boilers...	180	....
Donkey boilers...	....	180
Galleys..	10	....
Coal used in laying fires, etc., includes, below :		
Laying fires...	31	....
Raising steam, etc..	15	56
Lying in river......................	....	....
Coal used between New York, etc., includes below:		
Consumption in main boilers between } New York and Sandy Hook........	70	....
Consumption in main boilers between } Needles and Southampton..........	15	85
Consumed for other purposes includes.		
Donkey boilers at sea..	....	....
Galleys at sea.......	15	15
	336	

THE LOG OF A LINER.

The log of a first-class liner is usually protected from the eyes of the public, and the necessary and important facts contained therein kept a strict secret. The majority of logs are, as a general rule, condensed down to the required amount on arrival at headquarters, or shore technical department, and entered accordingly in the half-yearly report, which eventually finds its way to the manager's sanctum. The casual glance from a visitor, or an engineer with no marine experience, at the log of a chief engineer of one of the crack liners, would undoubtedly astonish him, and greatly increase his respect for the staff below. Even to an experienced "tramp" engineer the amazing accumulation of figures would appear almost incredible for a six-and-a-half days' run, but the data contained therein is absolutely essential to the official staff if they are to get facts concerning the efficient working of the engines. Some of the liners crossing the Atlantic carry as many as 15 to 22 engineers, including electricians, refrigerating, and deck engineers; but, I can safely say, only one, or possibly two, in each ship can fill up a log according to the requirements of the theoretical staff of the various lines. Stating a case of a liner that recently left England, the chief engineer had a vacation for one voyage, but before leaving the ship discharged his clerk, who had apparently during the voyage misconducted himself. The senior first assistant was of course promoted to chief engineer, and under the circumstances had to engage a new clerk. On arriving at the home port again the log was forwarded to the office; but the figures and data were decidedly inaccurate, and naturally so, because the man had not had a chance for probably five or six months to see the chief's log at all.

So, for the future benefit of junior engineers, this article is written; a typical modern liner is taken, and all the calculations are from actual practice. Some decimals are worked out to two or three places, others to only one, but quite sufficient for an example. Now the run, or distance, between the Needles and Sandy Hook light vessel, in accordance with the captain's report, is 3,046.5 knots, or nautical miles, and the difference in time between the two places is roughly about five hours; so the ship's clock will have to be put back about 40 to 45 minutes every day, according to the ship's performance. Now if we refer to the log, the number of hours and minutes contained in the first day are 24 hours 53 minutes. So the clock on this day was put back 53 minutes; hence the addition in the first place; but the regular steaming time turned out to be 19 hours and 48 minutes.

Now the next important item running along the first day's line, the 14th of February, is the revolutions per day; the pressures, temperatures, and density, of course, may be had from the gauges, thermometers, and salinometer, so we do not need any calculation. In taking the first day's run, the revolutions for the entire day

ABSTRACT ENGINEER'S LOG, S. S. AUSTRALIA, VOYAGE NO. 3, BOUND WEST.—*Continued.*

Passing Needles:	Intermediate	Ports.	Arriving Southamgton:
..........I ..........A.M. ..........P.M.			..........I ..........A.M. ..........P.M.
Passing Sandy Hook Light Ship: ....Feb. 20, 1905. ....2.40 A.M. ..........P.M.	....	....	Arriving New York: ....Feb. 20, 1905. ....9.19 A.M. ..........P.M.

	Air Pressure by Water Column.			Height of Barometer.	Temperatures.																	
	Fan Discharge.	Air Reservoirs.	Ash Pits or Stoke Hold.		Sea Water.	Feed Water.		Hot Well.		Engine Room.		Boiler Room.				Funnels.			Atmosphere.	Gases at Fan Suction.	Air Reservoirs.
						Port.	Stb'd.	Port.	Stb'd.	Port.	Stb'd.	No. 1.	No. 2.	No. 3.	No. 4.	No. 1.	No. 2.	No. 3.			
..	2½	1⅞	1	30.03	52	192	196	118	119	89	91	91	88	76	95	400	440	..	51	102	203
..	2½	1⅞	1	29.93	53	202	200	123	122	97	100	101	95	77	100	450	460	..	54	104	205
..	2½	1⅞	1	30.29	55	202	201	122	123	94	98	98	92	81	100	440	460	..	54	106	204
..	2½	1⅞	1	29.67	53	199	199	120	122	87	87	90	90	80	94	450	460	..	53	104	205
..	3	2¼	1¼	29.69	41	199	200	121	121	82	82	79	72	62	83	440	470	..	36	94	193
..	3	2¼	1¼	29.53	46	201	202	121	122	86	88	87	77	65	95	440	460	..	41	101	201
..	3	2¼	1¼	29.84	41	200	202	121	121	80	82	84	81	70	89	440	460	..	33	100	201
..	..	..	..	.....	..	...	...	...	...	..	..	..	..	..		...	...	..	..	...	...
..	..	..	..	.....	..	...	...	...	...	..	..	..	..	..	..	...	...	..	..	...	...
..	..	..	..	.....	..	...	...	...	...	..	..	..	..	.	..	..	...	..	..	...	...
..	2¾	2	1⅛	29.85	49	200	200	121	121	88	89	90	85	73	93	437	458	..	46	101	201

Oils.

	Eng. Oil.	Cyl. Oil.	Lamp Oil.	Patent Grease.
Remaining on board from previous passage..	1,389	143	90	220
Received on board at Southampton..........	....	....	360	....
Total remaining and received..........	1,389	143	450	220
Oil used in port for various purposes.........	127	12	....	....
Oil used in filling cups, etc., leaving..........	40	....	....	....
Oil used for refrigerating engines..........	7	....	....	....
Oil used for fan engines..........	42	....	....	....
Oil used for electric engines..........	42	....	....	....
Oil used for main engines on passage..........	400	42	....	....
Total consumption..........	658	54	150	....
Remaining on arrival at New York.....	731	89	300	220

are 103,540, port engine, the minutes actual steaming time 19 hours 48 minutes = 1,188 minutes; therefore we have $\frac{103,540}{1,188}$ = 87.1 revolutions per minute for the port engine; starboard engine is obtained in the same way, viz., $\frac{102,090}{1,188}$ = 85.9 revolutions per minute, as may be seen from the log.

The following column contains data which is closely observed by the "staff," namely, coal, an important matter on a liner. Here we have 212 tons per day. Every portion of a ship's bunker is known to the senior engineers, the spaces in between the stringers, angles, and webs are accurately worked out, and the engineer responsible for his watch is able to give a very reasonable estimate of the coal consumed on his "turn" by simply counting the number of spaces denuded of coal during the four hours, and multiplying the result by the quantity individually held. If various small spaces alongside the boilers hold 35.33 tons, which is all consumed in one watch comprising four hours, then 35.33 × 6 watches equals 211.98 tons, or approximately 212 tons for the first day's run. Of course all watches are not all alike; some consume more than others. Clearing the first day's coal we follow up with ashes. The usual method is to weigh the ash bucket or bag first; then pound or partly crush the clinkers and ash, fill up the bucket, deduct the weight of the bucket from the total or combined weight, and you arrive at the weight of the ashes. Count the number of buckets in one watch and multiply the result by the weight of the ashes. Say that there were 6,720 pounds of ashes in a watch of four hours, then 6,720 × 6 = 40,320 pounds per day, so $\frac{40,320}{2,240}$ = 18 tons, which gives the total amount of ashes in one day's run. The percentage of ashes, called for in the same line, is obtained by the formula $\frac{18 \times 100}{212}$ = 8.4 percent, which is the quantity of ashes in tons per day, multiplied by 100 percent and divided by the coal consumed.

In another column we have the distance by the engines in nautical miles or knots, by the well-known formula:

$$\frac{\text{revolutions of engines} \times 60 \times \text{pitch of propeller}}{6{,}080 \text{ feet}}$$

Now the mean revolutions, port and starboard engines = $\frac{87.1 + 85.9}{2}$ = 86.5, and the pitch of propeller is 25 feet 9 inches; therefore the formula will run $\frac{86.5 \times 60 \times 25.75}{6{,}080}$ = 21.98 knots per hour, and the total steaming time is 19 hours 48 minutes. So 21.98 × 19.80 = 435.20 knots per day, which we will call 436 knots to simplify the method. The following two columns we will omit because the result is obtained from the deck, and usually sent down to the chief engineer at noon each day. The slip percent is obtained by formula:

$$\frac{\text{engine knots—ship's knots}}{\text{engine knots}} \times 100.$$

Therefore by the log we have $\frac{436 - 376}{436} \times 100$ = 13.7 percent slip of propeller. Now, taking the last column in the same line, knots per hour equals:

$$\frac{\text{knots by observation}}{\text{hours steaming}};$$

therefore $\frac{376}{19.80}$ = 18.98, in round numbers say 19 knots. That

ABSTRACT ENGINEER'S LOG, S. S. AUSTRALIA, VOYAGE NO. 3, BOUND WEST.—*Continued.*

Docked and Finished with Engines.	Space for Intermediate Ports.			Sea Passage: Sandy Hook Light Ship to Needles.		
	......			Needles to Sandy Hook Light Ship.		
.... Feb. 20, 1905. ....9.19 A.M. ....P.M.	....	....	....	Days. 6	Hours. 14	Minutes. 35

Density.				Expansion.								Average I. H. P. Combined.	Revolutions.				Coal in Tons per Day.		
Water in Boilers.				H. P. Cyls.		1st I. P. Cylinder.		2d I. P. Cylinder.		L. P. Cylinder.			Total per Day.		Average per Minute.		Main Boilers.	Donkey Boilers.	Galley.
No. 1.	No. 2.	No. 3.	No. 4.	Port.	Stb'd.	Port.	Stb'd.	Port.	Stb'd.	Port	Stb'd.		Port.	Stb'd.	Port.	Stb'd.			
....	Fresh.	....	....	Full.		Full.		Full.		Full.		....	103 540	102 090	87.1	85.9	212	......	3
....	Fresh.	....	..	Full.		Full.		Full.		Full.		....	131,680	130,030	88.3	87.2	290	......	2
....	Fresh.	....	....	Full.		Full.		Full.		Full.		....	131,120	129,200	88.1	86.8	290	......	2
....	Fresh.	....	....	Full.		Full.		Full.		Full.		....	124.630	123,730	84.1	83.5	280	......	2
....	Fresh.	....	....	Full.		Full.		Full.		Full.		....	128,740	127,250	87.0	86	280	......	2
....	Fresh.	....	....	Full.		Full.		Full.		Full.		....	131,990	130,230	89.0	87.8	280	......	2
....	Fresh.	....	....	Full.		Full.		Full.		Full.		....	79,380	78,360	89.0	88	175	......	2
....	......	....	....	....		....		....		....		....	....	....	....	....	...	......	..
....	......	....	....	....		....		....		....		....	....	....	....	....	...	......	..
....	......	....		....		....						....	....	....	....	....	...	......	..
....	Fresh.	....	....	Full.		Full.		Full.		Full.		18,661.82	831,080	820,890	87.4	86.3	1,807	......	15

finishes the day as far as calculation goes. Oils are not taken into account until further on, as the total time has to be taken into account to get the average. The following days are of course worked out under the same rule, and the final result, which reads totals and averages, brings in a few more calculations.

In the first instance we take the actual steaming time between the Needles and Sandy Hook light ship; the total time according to the log is 158 hours 35 minutes. The revolutions for the voyage, port engine = 831,080, and the total steaming time 158 hours 35 minutes, but the stoppage for the pilot (11 minutes) has to be deducted, which brings the time to 158 hours 24 minutes, or 9,504 minutes. Therefore $\frac{831{,}080}{9{,}504} = 87.4$ average revolutions for the voyage, for port engine. The revolutions for the starboard engine are $\frac{820{,}890}{9{,}504} = 86.3$, and the mean revolutions for both engines equals $\frac{87.4 + 86.3}{2} = 86.85$.

The next item, and a very great one in the eyes of most firms, is coal. The consumption between the Needles and Sandy Hook light ship is 1,807 tons, and the steaming time 158 hours 35 minutes. So $\frac{1{,}807 \text{ tons}}{158.5833} = 11.39$ tons per hour, and $11.39 \times 24 = 273.36$ tons per day. The percentage of ash requires to be taken next. We have the proportion, 1,807 tons coal : 216 tons ash : : 100 percent = 11.9 percent of ash. The quantity per day will run at $11.9 \times 273.36 = 32.52$ average tons of ash per day. The engine oil used during the voyage for port and starboard engines is 400 gallons. To arrive at the consumption per hour and per day we have $\frac{400}{158.5833} = 2.53$ gallons per hour and $2.53 \times 24 = 60.72$ gallons per day. The cylinder oil is worked out the same way.

We now follow up with the average percentage of slip of propeller for the voyage, which will be (engine knots minus ship's knots) divided by engine knots and the result multiplied by 100. The example on the log will work out at $\frac{3{,}502 - 3{,}046.5}{3{,}502} \times 100 =$ 13.0 percent slip, and the average knots per hour in the next column is the distance traveled by the ship from the Needles to Sandy Hook light vessel, 3,046.5 knots, divided by the actual steaming time, or $\frac{3{,}046.5}{158.5833} = 19.21$ knots, which corresponds with the data contained in the log. The actual steaming time is 158 hours and 35 minutes, or 6 days 14 hours 35 minutes. This result is counted as the "sea passage"; the total passage, from dock to dock—that is, Southampton to New York—works out at 7 days 2 hours 18 minutes. The result is always obtained from the chief officer and entered on the log.

Now take the summary of coal consumption; the quantity remaining from previous passage, commonly called "old stock," is 410 tons. The total amount received on board at Southampton 2,188 tons; therefore 2,188 plus 410 equals 2,598 tons remaining and received. The coal used in port for working cargo and laying fires ready for starting away is 180 plus 56 equals 236 tons, so the total on board on leaving port is $2{,}598 - 236 = 2{,}362$ tons. Following upon this we have to obtain the coal consumed between the dock and starting point, viz., Southampton to the Needles, and from finishing point to dock. The consumption from Southampton to the Needles being 15 tons, and Sandy Hook light vessel to New York 70 tons, the consumption between the Needles and Sandy Hook 1,807 tons, and 15 tons total consumption for the galleys, the amount is 1,907 tons. Now the total on board at Southampton, 2,362 tons, minus the consumption, 1,907 tons, will leave 455 tons, which will naturally be the "old stock" on the termination of the voyage. The total consumption of coal from dock to dock is $180 + 56 + 70 + 15 + 15$ equals 336 tons plus 1,807, the consumption between points equals 2,143 tons.

The average indicated horsepower is arrived at by a method known to very few on board ship. The formula runs.

$$\frac{(\text{average rev. for the voyage})^3 \times (\text{total I.H.P. from cards})}{(\text{revolutions when cards are taken})^3}$$

= average I.H.P., so with the example we have $\frac{86.85^3 \times 19{,}413}{88^3} = 18{,}661.82 =$ average I.H.P.

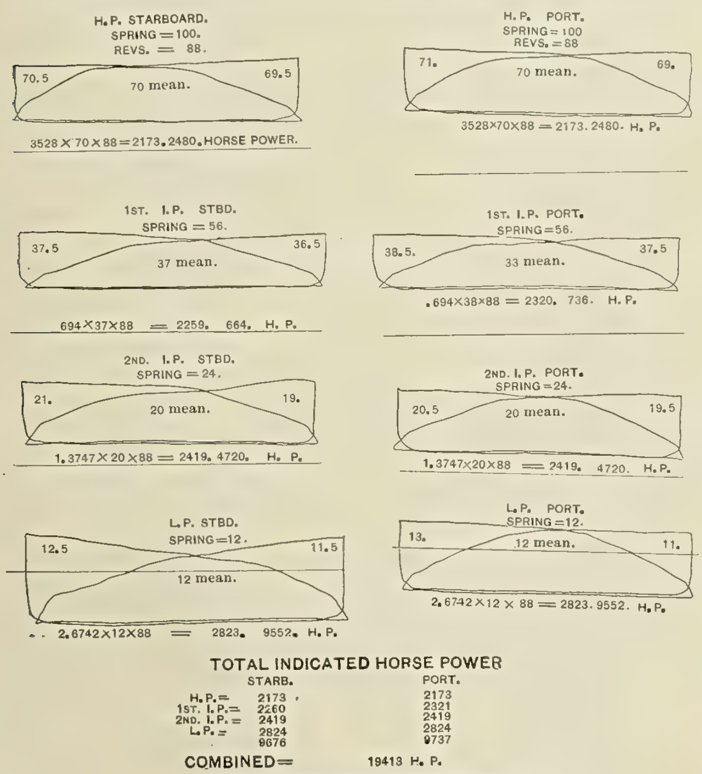
Far and away the most simple method of working out indicator cards is by the planimeter. Both the areas and mean effective pressures are accurately and quickly ascertained without the usual method of figuring and working out each card by ordinates. The set of cards shown was taken during the run from the Needles to

ABSTRACT ENGINEER'S LOG, S. S. AUSTRALIA, VOYAGE NO. 3, BOUND WEST.—*Concluded.*

Passage: New York to Southampton.			Draft, Leaving.				Draft, Arriving.				
Southampton to New York.			Forward.		Aft.		Forward.		Aft.		
Days.	Hours.	Minutes.									
7	2	18	26′	8″	27′	4″	24′	0″	25′	0″	....

Ashes in Tons per Day.			Oils. Gallons of Oil per Day.				Distances per Day.			Slip per Cent.	Knots per Hour.	Remarks.
Boiler Rooms.	Donkey Boiler.	Percentage of Ashes.	Engine. Port.	Engine. Stb'd.	Cylinders. Port.	Cylinders. Stb'd.	By Engines.	By Observation.	By Log.			
18	..	8.4	25	25	3	3	436	376	376	13.7	19	Light head wind and head sea.
32	..	11.	30	30	3	3	555	486.2	486 2	14.4	19.6	" " " " " "
34	..	11.7	30	30	3	3	552	481.4	481.4	12.7	19.4	" " " " " "
36	..	12.8	30	30	3	3	526	443.6	443.6	15.6	18.0	Strong head gale.
33	..	11.7	30	30	3	3	543	457.5	457.5	15 7	18.5	Fresh head wind and sea.
44	..	15.7	30	30	3	3	556	491.8	491.8	11.5	19.9	Strong beam wind and sea.
19	..	10.8	25	25	3	3	334	310	310	7 2	20 6	Light head wind and sea.
..	..	....	..	..	..	..	....	.....	.....	...	....	....
..	..	....	..	..	..	..	....	.....	.....	....	....	Stopped for pilot 11 minutes.
..	..		..	..	..	..	....	.....	.....	....	....	....
216	..	11.9	200	200	21	21	3.502	3,046.5	3,046.5	13	19.21	

Sandy Hook light vessel. The originals were worked out by the planimeter. The cards shown are not exactly accurate with the originals, but merely give an insight into the horsepower developed with twin-screw engines. The diameters of the cylinders are high pressure, 38½; first intermediate pressure, 54; second intermediate pressure, 76; and low pressure, 106 inches. The stroke of



INDICATOR CARDS TAKEN DURING THE RUN.

the engines is 60 inches. Now, to work out the constant the rule is: area of cylinders multiplied by twice the stroke (in feet) and divided by 33,000 foot pounds; so we have the high pressure running out at $\dfrac{(38\frac{1}{2})^2 \times .7854 \times 10}{33{,}000} = .3528$. The revolutions per minute of the engines = 88, mean effective pressure = 70; therefore the actual indicated horsepower developed in the high-pressure engine will be .3528 × 70 × 88 = 2,173.248. The decimal points in this case we will ignore for the sake of convenience. The cards shown in the sketch are all worked out, and, as may be seen, the total horsepower for the starboard engine is 9,676, and for the port engine 9,737; the combined indicated horsepower is 19,413. This last figure was used when working out the average I.H.P.

H. J. SPIERS.

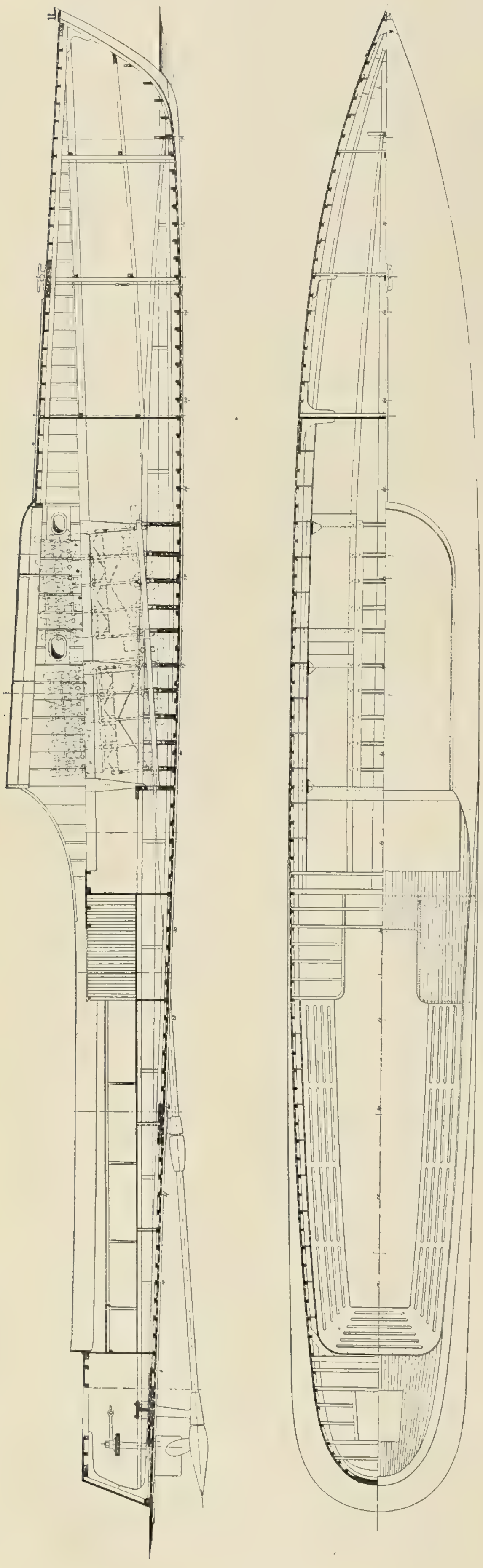
The United States Civil Service Commission announces an examination on September 13 and 14 for local and assistant inspectors of hulls to fill vacancies at Philadelphia, Pa., and other places, at $1,800 per annum. This examination is open to all citizens of the United States twenty-five to fifty-five years of age, who comply with the requirements. Applicants should apply to the commission at Washington for forms 1405 and 1087.

An examination on September 13 and 14 is announced for constructing engineer for sewers and water works in the Philippines. The salaries will range from $1,400 to $2,000; the age limit will be eighteen to forty years, and it is required that applicants should have had some experience in either the one line or the other. They should apply to the Civil Service Commission for forms 2 and 375.

OBITUARY.

Mr. Andrew Fletcher, of the W. & A. Fletcher Company, of Hoboken, has passed away at his country home at Bernardsville. He was the founder of the firm in 1853, the original name being Fletcher, Harrison & Company, which style was changed in 1881 to the present name of the firm. One of the notable products of the original firm, under Mr. Fletcher's management, was the famous Hudson River steamer *Mary Powell*, built in 1861.

Mr. Thomas Jackson Shaw died July 20 at his summer home at Holly Oak, Del. Mr. Shaw was first a pattern maker and then a draftsman in the Dialogue Shipyard, at Camden, N. J. He later became chief draftsman for the Harlan & Hollingsworth Company, of Wilmington, Del., and on his retirement, several months ago, was chief engineer and vice-president of that company.



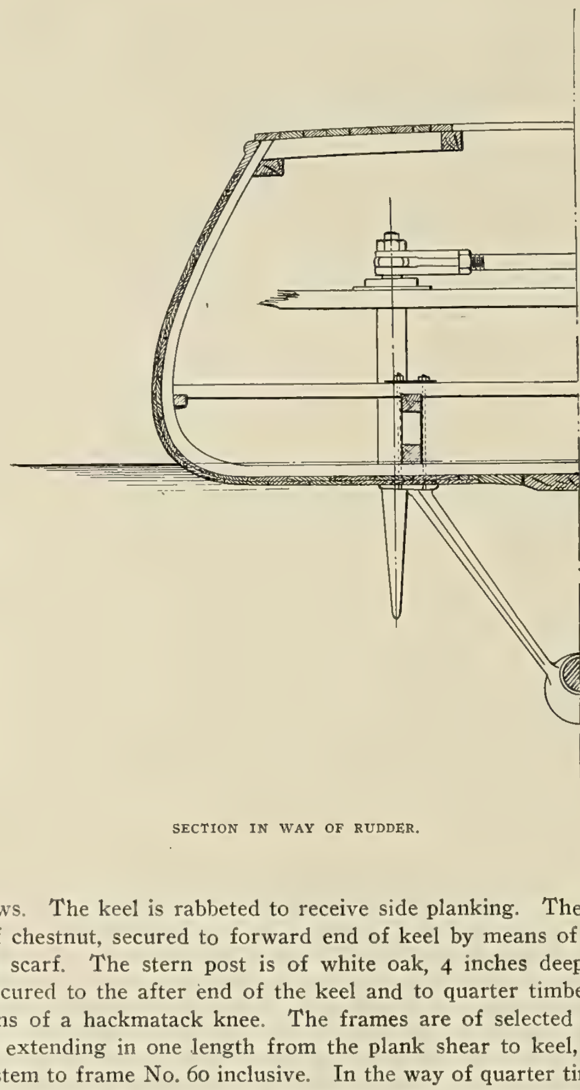
INBOARD PROFILE, HALF WEATHER PLAN AND HALF SCANTLING PLAN OF VERITAS.

THE NEW AUTO-BOAT VERITAS.

This motor boat is an improvement on the *Onontio,* which was constructed last year from the drawings of the same designer, Mr. Henry J. Gielow, of New York. In general dimensions the new boat has a length over all of 56 feet 8 inches, a length on deck of 55 feet 8 inches, a length on the load water-line of 54 feet 4 inches, an extreme beam of 7 feet and a draft of 3 feet.

As is usual in a craft of this size and description, the *Veritas* is constructed almost entirely of wood, with fastenings of copper and tobin bronze. In a few cases castings have been used of gunmetal and of manganese bronze. The lines are very fine and well calculated to give the high speed for which the boat was designed.

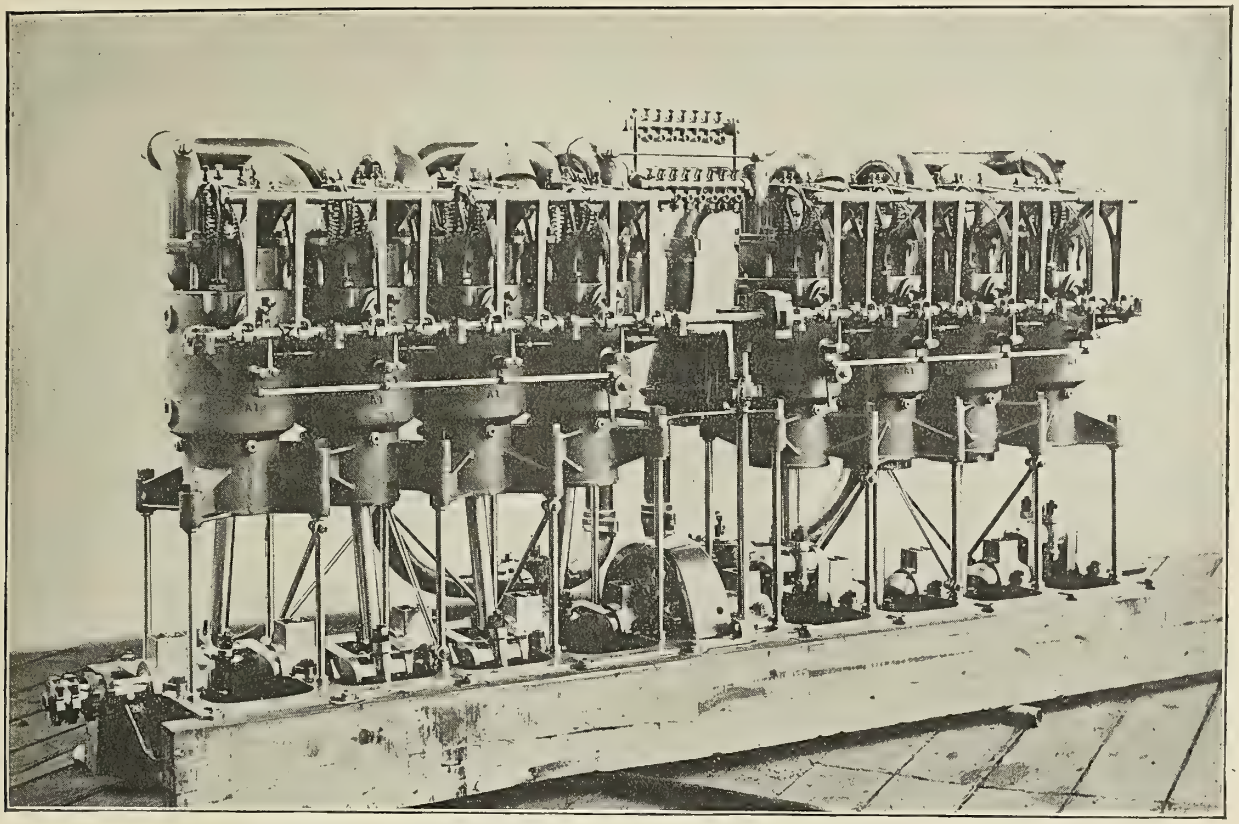
The keel is of white oak made in two lengths, having a width of 4 inches at the forward end and increasing to 10 inches amidships, at which width it is continued to the stern post. The scarf between the two sections of keel has a length of 24 inches, and is fastened with five ¼-inch copper rivets and two brass



SECTION IN WAY OF RUDDER.

screws. The keel is rabbeted to receive side planking. The stem is of chestnut, secured to forward end of keel by means of a 32-inch scarf. The stern post is of white oak, 4 inches deep, and is secured to the after end of the keel and to quarter timbers by means of a hackmatack knee. The frames are of selected white oak, extending in one length from the plank shear to keel, from the stem to frame No. 60 inclusive. In the way of quarter timbers the frames are in two lengths, connected with a hackmatack knee. From frame No. 60 to quarter timbers the frames overlap the keel or center line, reaching a maximum of 16½ inches at frame No. 40. All frames are spaced 8 inches between centers, and measure ⅞ by ⅞-inch at keel and ⅞ by ¾-inch at head. The frames between Nos. 32 and 53 extend up above the plank shear to form coaming and sides of turtleback.

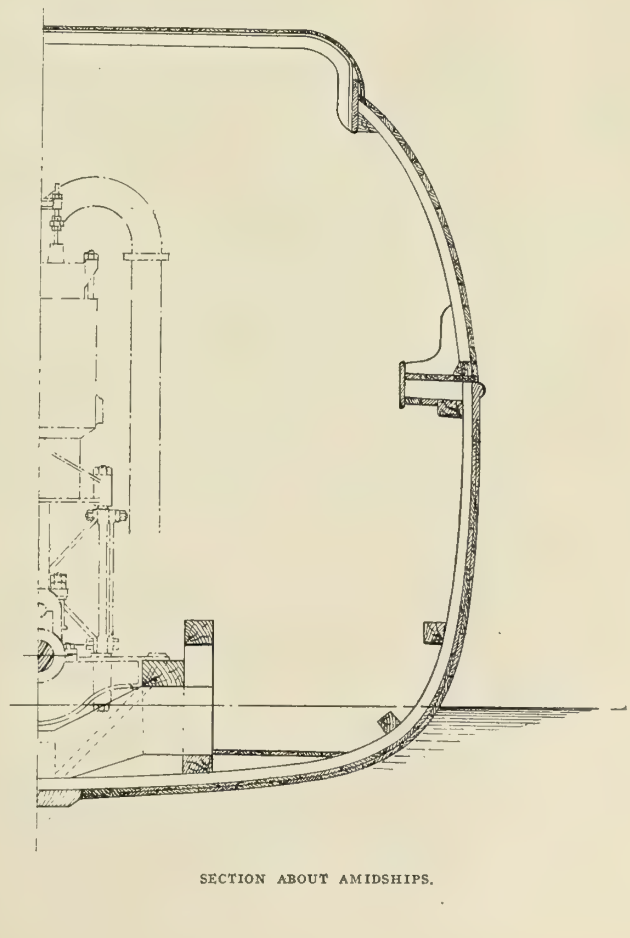
The floors forward of frame No. 59 are of white oak measuring 1¼ by 1½ inches. Side keelsons are fitted of Oregon pine measuring 2½ inches on the siding from frames 15 to 59 inclusive,



EIGHT-CYLINDER FOUR-CYCLE ENGINE OF VERITAS.

and diminishing to 1½ inches at the ends. The top strake measures 2½ inches to mold for ⅗ length amidships, and 1½ inches at ends, while the figures for the bottom strake are 1½ inches and 1 inch respectively. These keelsons are connected by hackmatack floors with cedar braces and stiffeners; also by a number of 2 by 2-inch spruce struts. Engine keelsons, measuring 2½ by 3½ inches, extend from frame 38 to frame 53, and carry the weight of the machinery. The deck beams are of white oak, molded 1¾ inches and siding 1 inch, except that beams at frames Nos. 1 and 4 have 1¾-inch siding and Nos. 6 and 32 2½ inches. All beams are spaced one on each frame and crowned 2 inches amidships, except that those for turtleback follow the lines of the turtleback.

The shear strake is of white oak ⅞-inch in thickness and about 4½ inches wide, the lower edge being rabbeted to receive the double planking. It is worked with a molding 1$\frac{3}{16}$ inches in thickness. The bilge strakes are of clear Oregon pine in one length, sided and molded 2 inches for ⅗ length amidships, tapering to 1½ inches at ends. All other planking is in two thicknesses with a width of 4 inches on the sides, increasing to 5 inches on the bottom. The inside thickness is of cedar, $\frac{5}{16}$-inch thick, and the outside of mahogany, ⅜-inch thick. These are separated by Union silk, covered with varnish, and are held together with button-headed brass screws. The material was planed both sides to a uniform thickness before being fitted. The plank shear is of mahogany ⅝-inch thick on outside and ½-inch on inside, and 4½ inches wide, fastened to each beam and to edges of shear strakes with brass screws. The deck plank is of white pine ½ by 2½ inches at stern and amidships and ⅜ by 2 inches on turtleback, the seams being laid in white lead. There are three bulkheads, located respectively on frames 6, 32 and 59. All are constructed of white cedar in two diagonal layers each ¼-inch in thickness, with a layer between of Union silk covered with varnish, and all fastened together with copper rivets. There are two hatches, one of which is located in the bulkhead on frame 59, with a clear opening of 15 inches vertically and 18 inches transversely, while the other is in the after deck and measures 20 by 24 inches. The cockpit extends from frame 6 to frame 26 and measures 13 feet 3 inches in length, with after corners rounded, and with a forward extension for the helmsman measuring 2 feet 8 inches long and 2 feet 9 inches wide. The sides of



SECTION ABOUT AMIDSHIPS.

the cockpit are parallel with the sides of the vessel and at a distance of 4½ inches from them. The floor is of ash ⅜-inch thick, the coaming of white oak ⅜ by 9½ inches and projecting 6 inches above plank shear, while a white oak molding is worked along the deck. Along the sides and after end of cockpit are fitted stationary seats 15 inches wide, supported along the inboard edge by eight turned mahogany stanchions.

The engine, designed and built by Mr. James Craig, Jr., of New York, is of the four-cycle type, with eight cylinders arranged in two tandem groups of four cylinders each. The cylinders measure 7¾ inches in diameter, with a stroke of 9 inches, and were designed to give a total of 175 horsepower at 650 revolutions per minute. Maximum speed is obtained with 800 revolutions per minute. The bedplate is a casting of manganese bronze, with vertical members and top and bottom flanges, forming a very rigid girder structure. It is made in halves, one for each group of cylinders. The vertical members consist in each group of ten steel rods ⅞-inch in diameter, passing through projecting lugs forming part of the cylinder castings. The flywheel, which, on account of the high speed of revolution, has been made small and light for the power developed, is situated between the groups of cylinders, and measures 18 inches in diameter, with a face of 5 inches. It serves as a coupling between the two groups, and permits the forward set to be uncoupled when desired. The engine, complete, weighs 3,500 pounds.

The cylinders have the usual encircling water jackets, and the heads form jackets for the valves, which pass through them. The water is carried from the cylinder water jacket to the head by means of a brass pipe, and thence by another pipe to the exhaust pipe. There are two inlet and two exhaust valves, operated by bell-crank levers, in each head. The gear is so arranged that one of the valves is opened slightly in advance of the other. The oil-feed reservoir and the dynamo for ignition purposes are placed between the groups of engines, above the flywheel.

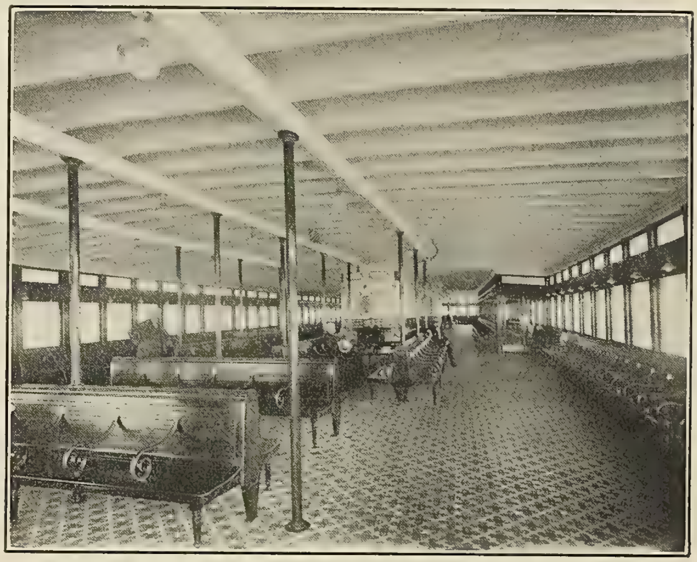
The propeller wheel has a diameter of 30 inches and a pitch of nearly 60 inches, with feathering blades. The reversing gear is of the bevel gear type, and operates by means of a screw and handwheel on the port side.

There are two rudders of manganese bronze operating through rudder ports consisting in each case of a composition casting 3½ inches in length with a 2⅜-inch hole through the center. The upper end of this hole is threaded for a brass pipe of 2¼-inch inside diameter, while the lower end is fitted with a phosphor bronze bushing 3½ inches long and ¼ inch thick, leaving an opening in bushing of 1⅞ inches diameter. The lower end of this composition casting fits into a brass plate fastened to under side of hull. The rudders themselves have each a stock of 1⅞ inches in thickness in way of phosphor bronze bushing, tapering to 1 inch at the upper end. The part below the hull is flattened out and drawn down to ¼ inch in thickness at the lower end, and is worked to sharp edges at forward and after sides. The upper end is tapered and fitted with a tiller yoke, adjustable connecting bar and bearings. The boat is steered by a 20-inch brass steering wheel of the automobile type, with a rack and pinion. This wheel is located in the forward end of cockpit and operates a tiller rope of steel wire 1 inch in circumference through composition sheaves 5 inches in diameter.

The shear strake is finished in varnish thoroughly rubbed down. From the under side of this strake to within 2 inches of the designed load water-line the outside of the hull is painted white, and from this line down she is painted with green copper paint. The turtleback and deck are finished in varnish, as is the case with the under side of the deck and turtle back and the inside of the hull down to a level just below the cockpit floor. From this line down to the keel the floor or bottom of the hull is painted with red lead and oil. The name and port are put on the launch in gilt letters, and a gold strip is run all the way around the hull. The general *ensemble* is a boat of very pleasing appearance. The owner is Mr. Alexander Stein.

The New Staten Island Ferryboats.

The ferryboat *Manhattan*, shown in the accompanying photographs, is one of five which the Maryland Steel Company of Sparrow's Point, Md., contracted about one year ago to build for the City of New York, for the Staten Island route. They are the largest and fastest ferryboats yet built for New York



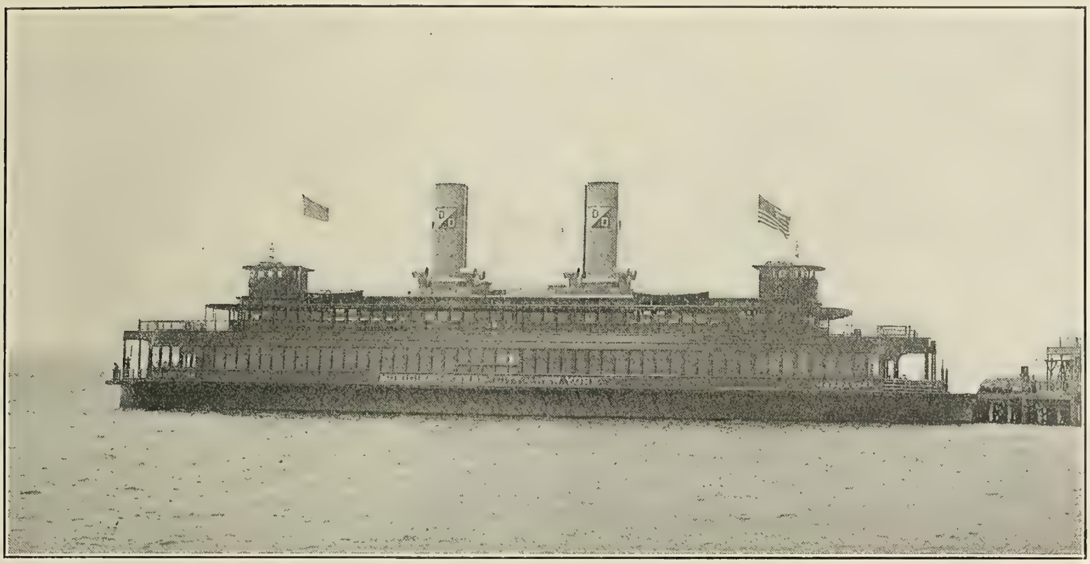
ON THE UPPER DECK.

harbor, and, in a recent trial on the Chesapeake, the *Manhattan* made a speed of over 18½ miles per hour against the tide. The dimensions are 250 feet over all, 66 feet beam over guards, and 19½ feet deep. The hulls are of steel, so sub-divided by bulkheads as to make them practically unsinkable. None of the bulkheads have doors, so that nothing is left to chance in case of

ONE OF THE MAIN STAIRWAYS.

collision, and duplication of appliances has been carried out much more than is usual, guaranteeing immunity against disablement.

The interior finish is mahogany, with composite board panels, the seats being mahogany. The upper saloon is covered with rubber tiling, and the lower saloon with linoleum. An innovation that will be appreciated is the complete separation of the smoking saloon from the other parts of the boat, which is accomplished



THE NEW STATEN ISLAND FERRYBOAT MANHATTAN.

by the location of the stairs. The toilet arrangements are ample, and are of the most modern character. Everything necessary in the way of life-saving appliances is provided, as called for by the latest steamboat inspection rules. The public will undoubtedly be pleased with the very liberal electric lighting installation, there being two large duplicate plants.

The propelling machinery consists of a double compound engine with cylinders 22½ and 50 inches in diameter by 30 inches

IN THE LOWER SALOON.

stroke, driving a propeller at each end of the boat, the shaft being continuous. The boilers are of the Babcock and Wilcox water-tube type, having 340 square feet of grate and 12,500 square feet of heating surface. There are four of them, two in each fire room on either side of the engine compartment. Independent pumps and various auxiliaries are supplied in a most liberal manner. Two complete duplicate sets of signal appliances are installed to insure against breakdown.

It is to be regretted that the city is to be denied the immediate use of these fine boats, due to a failure to provide suitable terminal slips. The dilatory tactics resulting in this state of affairs will probably delay the inauguration of the new service for several months. The boats will be found fully described in Marine Engineering for September and October, 1904, and January, 1905, at pages 407, 473 and 35.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, report under date of August 10, 1905, the following percentage of completion of vessels building for the United States Navy:

			July 1.	Aug. 1.
BATTLESHIPS.				
Virginia	19 knots.	Newport News Co.	89.71	91.37
Nebraska	19 "	Moran Brothers Co.	75.	77.
Georgia	19 "	Bath Iron Works	82.66	85.
New Jersey	19 "	Fore River Shipbuilding Co.	86.2	87.7
Rhode Island	19 "	Fore River Shipbuilding Co.	88.8	92.1
Connecticut	18 "	Navy Yard, New York, N. Y.	80.74	83.67
Louisiana	18 "	Newport News Co.	80.79	82.81
Vermont	18 "	Fore River Shipbuilding Co.	53.6	57.1
Kansas	18 "	New York Shipbuilding Co.	55.1	57.8
Minnesota	18 "	Newport News Co.	68.	69.9
Mississippi	17 "	Wm. Cramp and Sons	31.28	34.48
Idaho	17 "	Wm. Cramp and Sons	29.57	33.22
New Hampshire	18 "	New York Shipbuilding Co.	11.2	15.2
ARMORED CRUISERS.				
California	22 knots.	Union Iron Works	78.3	80.4
South Dakota	22 "	Union Iron Works	76.1	78.9
Tennessee	22 "	William Cramp and Sons	79.4	82.02
Washington	22 "	New York Shipbuilding Co.	79.1	82.03
North Carolina	22 "	Newport News Co	9.14	12.2
Montana	22 "	Newport News Co	7.98	10.81
SEMI-ARMORED CRUISERS.				
St. Louis	22 knots.	Neafie and Levy Co.	67.4	71.4
Milwaukee	22 "	Union Iron Works	75.2	79.
Charleston	22 "	Newport News Co.	97.	99.
GUNBOAT.				
Paducah	12 knots.	Gas Engine and Power Co.	88.9	92.4
TRAINING SHIPS.				
Cumberland	Sails	Navy Yard, Boston	95.	95.
Intrepid.	"	Navy Yard, Mare Island	97.5	97.5
TORPEDO BOATS.				
Goldsborough	30 knots.	Wolff and Zwicker	99.	99.
O'Brien	26 "	Lewis Nixon	99.	99.
SUBMARINE TORPEDO BOATS.				
Submarine No. 9		Fore River Shipbuilding Co.	0.	12.6
" " 10		Fore River Shipbuilding Co	0.	11.5
" " 11		Fore River Shipbuilding Co	0.	11.5
" " 12		Fore River Shipbuilding Co	0.	11.5

SHOP ECONOMICS.

BY THEODORE LUCAS.

For all manufacturing in general, as well as for the production of ships and their machinery in particular, the equation has to hold good:

Cost + profit = selling price.

The selling price is the only factor in this equation that is subject to competition. It is therefore a quantity that can be influenced very little by a single concern, but which will remain more or less at a stationary figure, until changes in the material or labor cost affect all competitors in about the same way.

The two other factors are dependent entirely upon the builder in their interrelation, such that a relatively small production cost is accompanied by a relatively large profit, which of course is the desired result of all manufacturing activity.

Dividing the production cost into three subdivisions, namely:

General expense;

Material cost;

Labor and tool cost;

it is apparent that each of these subdivisions should be as small as possible to realize the minimum of total production cost. The great desideratum for lowest cost is therefore to make sure that each and every one of the subdivisions is the lowest possible not only in its totality, but also in each and every one of the component detail parts that comprise the whole subdivision, down to the smallest unit and the minutest operation of every individual worker or machine.

This certainty of efficient individual unit operation should then be gained with the minimum of supervision in an automatic manner, that through clearly prescribed channels will accumulate the desired data accurately, quickly, and cheaply.

The ablest mechanical minds have bent their energies—in the last 10 to 15 years with rapidly increasing intensity—upon the task of devising methods and systems by which a more or less automatic collection of the vital data can lead to the certainty of lowest production cost of even the minutest individual unit operation.

What is evidently needed to accomplish this purpose is a comprehensive internal system of cost accounting that in full completeness is at the same time so lucid and simple that each and every unit operation can be singled out for comparison with the best record or standard, to ascertain if it has been accomplished at lowest cost or not.

To enable all clerks, draftsmen, foremen, and workmen to file or record unit operations, in clear, accurate, and lucid manner, it is necessary to predetermine a full classification of all operations in form of data blanks or cards, that clearly state what should be recorded upon them.

A classification with subdivisions that probably will cover all work performed in shipyards has been used for weight estimates and been advocated for wider application by the writer as follows:

A. Steel in hull.
  I. Longitudinal and transverse framing and plating.
  II. Decks.
  III. Castings and forgings.
  IV. Bulkheads.
  V. Miscellaneous steel work.

B. Cement, paint, tiling.

C. Carpenter work.

D. Joiner work.

E. Outfit and equipment.
  I. Fittings for handling whole ship.
  II. " " supply and discharge.
  III. " " interior communication.
  IV. " " safety and protection.
  V. " " ornamentation.

F. Boiler-room weights.

G. Engine-room weights.

H. Shaft-alley weights.

I. Coal.

J. Fresh water, stores, provisions.

K. Crew, passengers, effects.

L. Cargo.

As seen the classification takes as the basis the complete weight distribution of a ship and distributes even the trial-trip expenses to the items J, K, and L.

The leading principle throughout the classification is to charge every possible expenditure to specific contracts and jobs, thus disposing of them when the contract is completed.

As few items as possible should be charged to general expense. This latter should be confined primarily to salaries of the general officers of the concern, to selling, advertising, and traveling expenses incurred not directly in connection with special contracts.

In regard to items like taxes, insurance, power, heating, lighting, wages for engineer, firemen, watchmen, general laborers, etc., it seems—at least to the writer—that it would be possible to allot these charges to special operations and contracts. For example, taxes are levied on real estate, which supports various buildings, in which a number of men work a certain number of hours. The total number of men hours, say 3,000,000 per year, can be placed in relation to a tax expenditure of say $3,000; resulting in a rate of 0.1 cent per man hour. Such figures can similarly be approximated for fire and accident insurance, taking care to charge certain departments perhaps with a higher rate than others, as their greater risk or larger use of buildings or appliances make such differences desirable.

Expense for power can readily be distributed to different tools, forming one of the charges in the determination of the total tool cost.

Heating and lighting can be placed in relation to men hours, taking care to proportion this part of steam expenditure to that for power, so that at the end of the year the total charges are equal to the sum total of all direct recorded expenses for coal, oil, supplies, wages of engineers and firemen.

In a short time it will be possible to establish average rates, by which a fair distribution of the expenditures to productive detail operations of men or tools, or to the care of materials, can be secured.

The item of material cost is readily determined by a centralized store-room system with receiving and shipping branches under the supervision of a purchasing agent or clerk. The principle rigidly adhered to is that no materials of any kind are moved or given out without a bill of material, a requisition, or receipt. These may be conveniently executed in card form, stating distinctly the contract job or special application of such material in rough or finished state, of auxiliary machinery, or even of completed machines, engines, boilers, turrets, masts, etc. In the latter cases the requisition or receipt takes the form of a bill of material, specifying clearly all parts and attachments. Such a clear record should and does do away with a great deal of carelessness or dishonesty that frequently takes place in large establishments with regard to the material question. That nocturnal small boats carry sometimes loads of brass fittings or lead and copper pipe from partly completed ships, or that tons of spoiled material are sunk into the river or hidden in dark corners are occurrences that an intelligent store-room system with clearly defined responsibility of foremen and workmen can readily avoid.

For the keeping of such stores' accounts the simplest form of ledger with credit and debit columns, in either book or card form, can efficiently perform the duty of placing responsibility.

Tool and fixture rooms, which for convenience are located in the different departments, can readily be treated as adjuncts or special branches of the general store-room system, with the same method of card or check control and full record of receipts and deliveries.

The most important item of internal shop economics is that of the labor cost, and conveniently connected thereto that of the tool cost. This is probably the one that in most cases of manufacturing activity—whether in regard to hulls, boilers, engines, auxiliaries, or other products—contributes the largest percentage of the

400′ × 52′ × 30′ STEEL IN HULL. TABLE A.

		Weight.		Material.	General Expense.	Correspondence, Clerical Work.	Drafting, Ordering, Mold Loft.	Freight, Handling, Setting Up.	Making Molds, Laying or Shearing, Planing.				Punch, Drill, Countersink.		Bar Furnacing.		Plate Flanging, Rolling.		Riveting, Bolting.		Caulking, Chipping.		Painting, Cement.	
		Tons.	Pounds.	$	$	$	$	$	Sq. Ft.	$	Feet.	$	No	$	Feet.	$	Sq. Ft.	$	No.	$	Feet.	$	Sq. Ft.	$
1	I.—LONG. TRANSV. FRAM. PLATE.																							
2	Keel, Longitudinals	148.0	334,500	5,686.50	1,337.50	664.30	537 70	1,012.40	19,730	169.40	9,080	292.30	48,120	552.10	5,21	379.3	3,370	478.30	18,600	364.70	3,710	296.30	38,400	114 10
3	Shell Plating	592 0	1,327,800	22,572.60	4,713.40	782 40	1,114.90	4,117.40	120,380	693.20	63 700	1,678.10	379,800	3,876.80	....	......	50,370	2,872.90	159,800	4,764.20	37 600	2,474.90	233,000	897 40
4	Inner Bottom	135.0	303,700	5,162.90	1,210.70	602.30	899.70	917.90	30,340	273.10	18 500	475.30	63,360	817.00	....	......	3,340	382.80	23 200	679.40	8 860	627.40	141,200	517.70
5	Frames, Reverse Frames	237.0	533,100	9,062.70	2,131.00	1,014.20	1,314 70	2,697.40	32,130	299 40	4 320	186.80	153,410	1,765.50	68,37	3 979.4	....	......	33,200	840.70	3 620	216.20	44,360	238 60
6	Floors, Webs, Brackets	179.0	402,800	6,847.60	1,602.80	814.30	734.60	1,814.70	31,430	187.60	34,170	736.70	79,340	1,107.40	....	......	8,470	711.40	21,420	473.90	1,230	161.30	34,27	111.90
7	II.—DECKS.																							
8	Beams, Brackets	193.0	432,100	7,345.70	1,731.40	796.40	627 80	1,364.90	8,100	64 10	5,260	122.30	38,350	374.10	9,950	437.1	730	31.60	9,320	197.30	640	27 30	26,490	84.20
9	Deck Plating	331.0	741,600	12,607.20	2,963 20	973 40	813 40	2,127.10	49,320	391.50	29 470	759.40	115,710	1,516 60	....	......	33 140	1,923.40	43 260	1,184.90	23 270	1,474.10	46,710	247.80
10	Stringer Bars	23.0	51,500	875 50	207.20	97.30	78.10	194 30	7,130	57 30	230	3.70	27,340	189 80	6,010	291.7	....	......	9,360	248 10	9,420	710 70	3 730	46.10
11	Stanchions, Stringers	39.0	87,800	1,492.60	336.90	158.20	97.20	311.40	18,370	179 10	340	8.40	36,710	378.20	5,480	302.4	....	......	8,740	175.70	470	21.30	15 32	48.20
12	III.—CASTINGS, FORGINGS.																							
13	Stem, Stern Post	17.0	38,100	1,847 70	139 00	73 40	172.60	119 40	113	3 20	173	4.30	730	11 70	....	......	....	......	518	20.10	126	10.10	310	1.20
14	Rudder Complete	13.0	29,200	1,496.40	107.30	54.20	146.70	97.80	107	2.60	78	3.80	670	9 40	....	......	200	4.70	620	21.30	48	8.60	510	1.80
15	Rivet Heads	77.0	172,800	2,939.60	......	......	......	428.60	.....	......	....	......	.....	......	....	......	....	......	...	......	....	......	.....	......
16	IV.—BULKHEADS.																							
17	Transv., Long. Bulkheads	97.0	217,400	3,695.80	853.10	474.00	714 90	712.80	26,060	173.20	20,120	332.40	70,370	963.40	2,840	287.30	4,670	282.30	20,760	478 40	4,850	397.40	43,020	131.70
18	Casings, Deck Houses	23.0	51,500	875.50	199.70	103.40	235.70	234.70	7,830	61.10	2,830	63.90	23,420	317.50	420	121.70	1,940	231.20	5,430	121.20	1,970	249.80	11,04	35 20
19	V.—MISCELLANEOUS STEEL.																							
20	Doublings, Foundation	17.0	38,100	647.70	162 00	78 40	......	137.40	5,390	67.90	1,930	51.20	20,240	296 30	570	126.30	1,830	191.70	5,340	137 10	940	141.90	8 920	26.90
	$183,032.70 = Tons, 2,121.0			83 154.00	17,685.20	6,686.20	7,704 40	16,283.20		2,612.70		4,718.60		12,175.80		5,975.20		7,110.30		9,707.00		6,817.30		2,402.80

total cost. It is for this reason that the greatest scrutiny of its amounts should be exercised, so that the lowest possible cost can with certainty be realized in all individual or unit operations. For such close investigation it is highly desirable, and perhaps imperatively necessary, to bring the expenditure of hours and money into a direct relation to accomplished results. These latter should be expressed in such simple and clearly defined form as to allow a ready comparison with similar operations. For example, in hull or boiler work there may be a relation established between cost and lineal feet flanged, planed, sheared, calked, rolled, bent, straightened, or square feet laid off, or holes of a certain size punched, drilled, countersunk, reamed, riveted, expanded, etc. Or for machine work a relation may be established between cost and square inches planed, turned, milled, slotted, shaped, ground, or a number of holes of a certain size drilled, tapped, studded, countersunk, etc. With such data on hand, an intelligent judgment and comparison of the efficiency in the execution of the work can be gained, such as no general charge system probably can realize.

Modern manufacturing methods have long realized that work for the shops has to be laid out and prepared for execution, and it is probably beyond doubt established that the cost of production is small in direct proportion as the layout is complete.

It is for this reason that drafting is carried out more and more completely, even the smallest items being fully detailed and determined. The drafting room is the place in which to prepare not only bills of materials but also bills of operation that state in tabular form all the operations on individual pieces. Taking for example a steam cylinder, there may be determined the square inches of boring, facing, planing, and the number of holes drilled, tapped, studded, as well as the fitting of stuffing boxes, flanges, relief, drain and bye-pass valves, etc. From such a total bill containing space for filling in the hours and corresponding money expenditure after the work is done, it is readily possible to make out job or work orders, specifying in the form of an order only one individual operation out of the total on the bill.

The accompanying general table or bill, A, deals with hull work, but is equally applicable to boiler and sheet-iron work. It was prepared for estimating, and therefore contains only quantities and cost, as the vital characteristics. The wide possibilities of a well-developed unit system are shown therein clearly, as for a new estimate the quantities are even in the earliest conception of the design readily available, and from previous work records also accurate knowledge of their cost, thus leading quickly and with high accuracy to complete total cost values. With great celerity it is possible to allow for fluctuations in the price of raw material—sometimes perhaps only for a few special shapes—or in the cost of labor in all or only some departments.

For cost recording work the tables may with advantage be much larger and more complete, recording hours of labor besides quantities and cost. Separate tables may be executed for carpenter and joiner work, equipment, machinery, and other parts of the work.

A form of job or work order is shown in Table B, giving the general data on the front, while the time stamps and inspection data are to be recorded on the back. The cards are to be printed blanks and the items in the second column of the front are filled in by the estimating draftsman with exception of date, name, check number, tool, and tool time, which are supplied in the shop; and the items on the material which are supplied by the store room. The rotation of the card would be: from the estimating office to the store room, thence with the article to the shop, thence back to the store room with the completed article, and back to the recording office.

By preparing a copy of the total bill as shop order for the foreman, and all the job orders for the workmen beforehand in the estimating office, the routine in the shop would not differ materially from the usual one, the foreman giving out the cards with the work and having the time stamped on at beginning and end of operation.

TABLE B.

Front of Work Order.

1	Date.	June 13. 1905	
2	Name,	J. O. K.	
3	Check No.	1,076.	
4	Hull or Engine	Contract, 407.	
5	Job No.,	$\frac{17 \times 26\frac{1}{2} \times 40}{24}$	
6	Drawing No.,	7.941.	
7	Pattern No.,		
8	Part,	Piston Rods.	
9	Size,	4¾″ × 6′ − 5½″	
10	No. Pieces.	3.	
11	Material.	Nickel Steel.	
12	M terial Good.	2 Pieces.	
13	Material Defective.	1 Piece.	¼″ Short.
14	Weight, Rough, inv.,	1,725½ lbs.	
15	Weight, finished.	1,573 "	
16	Tool No.	58	
17	Operation,	Turning.	
18	Rough,	1,155 sq. ins. × 3 =	3,465 sq. ins
19	Finished.	795 " " × 3 =	2,385 " "
20	Contract	Piece.	
21	Rate,	$1.50.	
22	Premium.		
23	Price,	$4.50.	
24	Time Limit,	18 Hours.	
25	Time of Tool,	12½ Hours.	
26	Rate of Tool, 58,	$0.20.	
27	Tool Cost,	$2 50.	
28			
29			

Back of Work Order.

Date,	June, 1905,	Forenoon. In.	Forenoon.	Forenoon.	Forenoon. Out.	Afternoon. In.	Afternoon.	Afternoon.	Afternoon. Out.
	Monday,								
13	Tuesday,			11.04	12.04	12.26			5 03
14	Wednesday,	7.24			12.02	12.29		3.37	
	Thursday,								
	Friday,								
	Saturday,								

Inspector.	S. F. P.
Date,	June 18 '05.
Time from	9.18
To	9.45
Good,	1 Piece.
Defective,	2 Pieces. Dia. 4¾″ sc.
Spoiled,	

With all work determined beforehand, the fullest distribution to the tools can be made in such manner that work of the same nature, like punching, shearing, drilling, turning, boring, etc., may be grouped together and thus keep one man on quite a run of work of the same nature, leading to fuller and more regular employment of the tool and greater efficiency of the man.

To secure quick and handy distinction and filing the job orders for the different departments may be printed on cards of different colors and may be notched for main subdivisions at the top and additionally at the side for further detail subdivision.

Thus it may be possible to employ for:

A white cards. B pink cards.

C and D blue cards.

E yellow cards. F green cards.

G and H red cards.

A would have from 1 to 5 top notches.

E would have from 1 to 5 top notches.

F would have from 1 to 2 top notches.

G and H would have from 1 to 4 top notches.

Systems of recording individual operations have wide possibilities. They record unmistakably the capacity of the workmen and tools, a fact that will be quickly realized by the men, spurring them on to more faithful discharge of their duties and quickly singling out the good men and efficient tools in an impartial manner.

The job tickets can be used directly for piece work and previous complete records of such individual operations can in the hands of a competent and judicious man lead to rate fixing that is fair to both employer and employee. Even for jobs of a new or complicated nature it is possible to fix a fair price by building up the total cost out of single operations, of which prices are on hand. Due allowance can be made for setting the work in tools, handling by crane, etc., leading for the totals to results that should prove just to the workman without that excess of earnings that by subsequent reduction produces much of the friction often connected with the practice of piece-work systems.

It may not be possible to always determine all of the operations beforehand, as defects or variations in complicated castings may demand changes in the operations, different sizes or spacing of studs or bolts, less finishing on certain surfaces than intended, etc. The job-ticket system, however, is so flexible that the foreman on his own or higher authority could cancel or alter certain tickets and items in the bill of totals and substitute or add others.

The tool cost is an item that in establishments employing many high-priced tools may prove of considerable value. The tool cost as distributed to the different jobs or operations may be considered as composed of an interest charge, a depreciation charge, a power and attendance charge, and a special tool, jig, and fixture charge. These different items can be figured to a rate per hour that allows immediate application on the same job ticket upon which the man running the machine records his activity.

Assuming the full usefulness of the machine as extending say over a period of ten years, at a certain mean number of hours of activity, the rate for interest and depreciation is directly available. The power charge is not so readily derived, but by having the yearly cost of the power and attendance and the total number of horsepower developed it is possible with the help of a few dynamometer experiments on different classes of machines to allot fair values of cost of power consumption to each machine. Where electrical driving of the machine tools is employed, the power consumption is, of course, much more readily determined from the readings of the measuring instruments.

The tool, jig, and fixture charge is generally a fluctuating one, as part of the work may demand a number of fixtures, while part may require none at all. Where special jigs and fixtures are made for one particular job it seems best to charge their cost entirely to the work, as often their application decreases the required number of men hours and thus forms a substitute for the decrease in labor cost. Where the fixtures are of such nature as to be readily available for other work a charge of a percentage of their cost may often seem the fairest.

A New Electrically Operated Ship Loading Device.

BY FRANK C. PERKINS.

In American as well as European harbors the great steamship lines are taking advantage of every labor-saving device available which will insure a more economical and rapid method of loading and unloading the great vessels lying at the wharves. The accompanying illustration shows a new electrically-operated registering conveyor capable of passing 4,000 sacks per hour to the deck of a vessel, automatically counting and registering them without error. The conveyor is of steel construction, 50 feet long, and is shown loading freight on the mammoth twin-screw steamer *Minnesota.* It was installed for the Griffith and Sprague Stevedoring Company by the Spence Registering Conveyor Company, of St. Paul.

The electrically-operated registering conveyor has a counter which works automatically, while the electric power is reversible, so that by simply operating a switch the freight may be either carried to the ship from the dock, or *vice versa,* as desired. A number of these electrically-operated labor-saving devices are in operation at the New York docks of the Old Dominion Steamship Company and the Northern Pacific Railway Company. An electric switch is provided at the upper end of the conveyor to stop the machine instantly if found necessary, or to reverse the direction of operation. There are spring-operated press-buttons provided which are depressed with the slightest pressure, thus engaging the arm of the counter and insuring a reliable tally.

THE LOADING DEVICE AT WORK ON STEAMSHIP MINNESOTA.

An electric motor of 5 horsepower is utilized for driving the traveling apron, which runs on steel anti-friction roller bearings, the rollers being set two inches apart on both sides of the conveyor, thus reducing the friction to a minimum. On this apparatus slats are used instead of a belt, so that cased goods, barrels, bales, or other kinds of package freight can be handled without difficulty. By means of a special controller the speed of the machine may be varied from 75 to 175 feet per minute according to the kind of material being handled.

In addition to the 50-foot steel conveyor shown in the illustration, two or more trailers may be utilized by means of sprocket chain and gearing. On the wharf or in-shore end a 35-foot trailer is used for conveying the freight from the inside of the warehouse, while another 35-foot conveyor of the same type carries the sacks or other freight across the deck of the steamer, delivering them to gravitation chutes, which are provided with a brake governing with the greatest ease the speed of descent to the hold of the vessel. This combination, including the gravitation chute, gives an equivalent of a single conveyor 120 feet in length. The gravitation registering chutes absolutely dispense with the services of tallymen, and are operated without motors of any type.

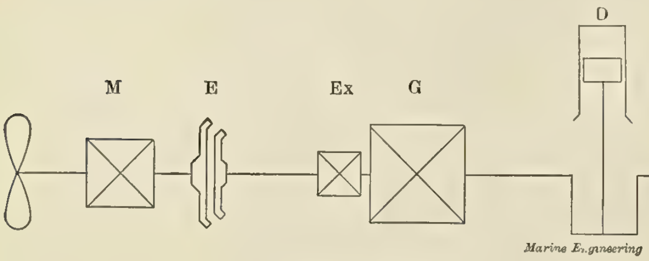
New Barge for the General Navigation Company of Lake Geneva.

BY L. RAMAKERS.

In view of the constant increase in water traffic, the General Navigation Company, of Lake Leman (Lake Geneva), Switzerland, has had constructed a new boat for freight service on that lake. The power required for propelling the barge, as well as for operating the winches, will be furnished by a petroleum motor of the Diesel pattern from the Sulzer works. This motor will operate in only one direction and at a constant speed. It is, therefore, necessary to make use of a special system of control for making landings, increasing or decreasing the speed of the boat, running backward, etc. After considerable study, it was decided to adopt as an intermediate piece of mechanism, electrical machinery, which offers a flexibility and elasticity impossible to be obtained with mechanical devices, the increase in weight which results having no great importance on a barge.

The arrangement adopted is as follows:

The Diesel motor, *D,* operates directly the generator, *G,* with an exciter, *Ex,* upon the same shaft. At the end of the shaft of this generator group is placed one of the members of a magnetic clutch, *E,* permitting the first group to be coupled to the second, which is composed of an electric motor, *M,* operating the propeller. At the forward extremity of this group is placed the second member of the magnetic brake. In order to start the boat, the Diesel motor is brought up to its normal speed, but the coupling, *E,* being loosened, the screw propeller is not operated. The exciter furnishes current for the field coils of both the generator and the motor. By means of a special starting device, the dynamo is first excited and the current of this acts in its turn to operate the motor. The screw being thus put into action, the boat moves on. When the generator and motor groups are running at the same speed, all that is necessary is to shove over to a stop the lever of the starting device, in order that the magnetic brake, under excitation from the generator, may be put in operation. At this



SCHEME OF APPARATUS.

moment the motor, *M,* is disconnected, and it is the petroleum engine which directly operates the screw, the two groups being rigidly joined together.

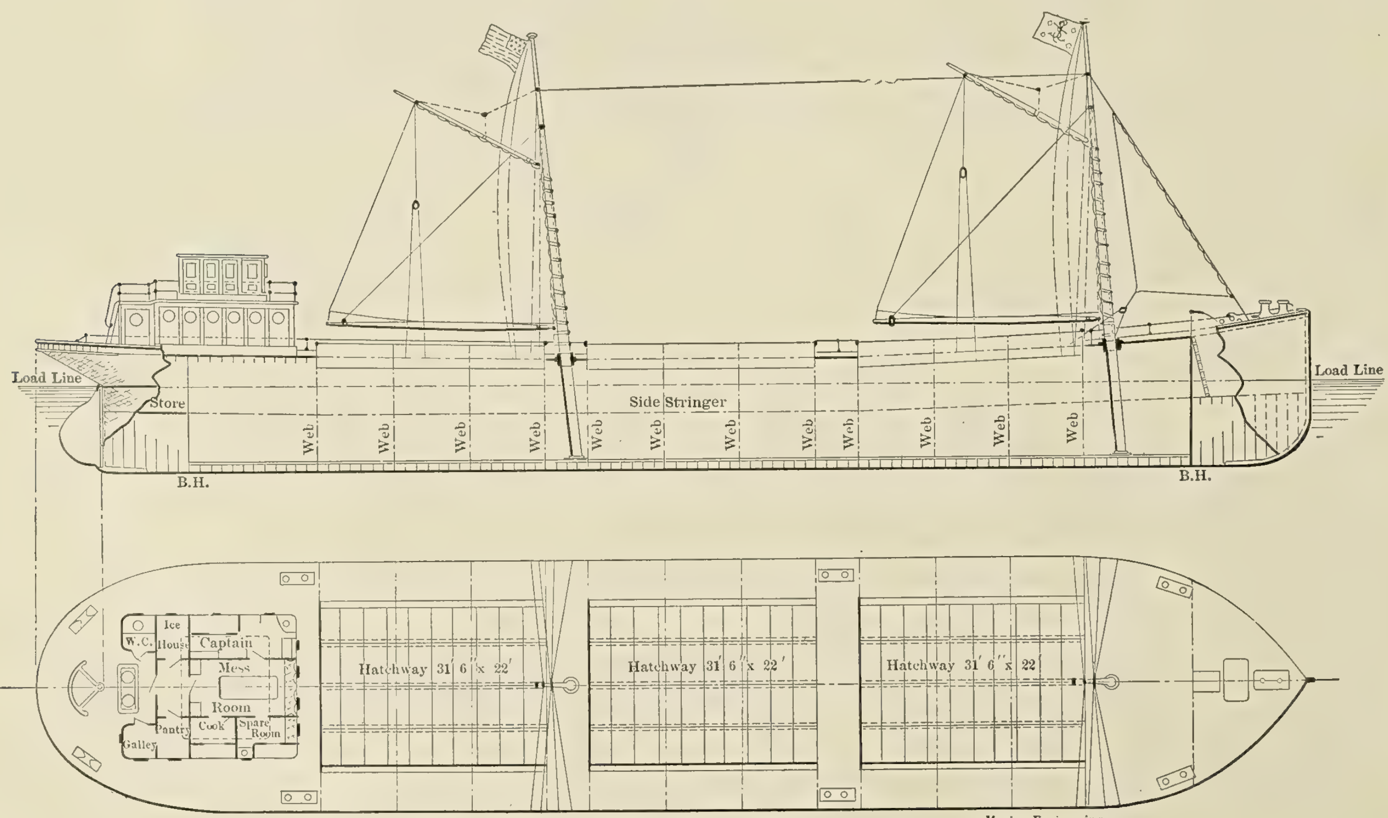
In order to move astern, it is necessary to replace the starting device lever to zero. The magnetic brake is then disconnected and the lever moved to the rear, when the current in the motor is reversed and turns the shaft in the other direction, operating the screw for rearward motion of the boat.

The Diesel motor gives from 40 to 45 effective horsepower at 260 revolutions per minute. The generator, which is of the direct-current type, has been designed to give voltages varying from zero to 110 volts, and furnish a normal of 20 horsepower, being able, however, to accept a momentary load of 40 horsepower. The motor may be operated from a zero speed to a maximum in either direction. It is, therefore, possible to obtain in making landings a satisfactory speed without jar or shock, while the starting device, as we have already said, acts not only upon the main circuit but also upon the excitation of the generator. For the other part of the power, a special electric motor has been designed to operate the capstan placed upon the boat, and a switch placed upon the switchboard near the machine permits the sending of the current from the generator into either the motor operating the screw or that for the capstan. The latter is composed of a roller with two drums operated by means of an endless chain, the drums being able to operate separately or together according to the weight of the load which is to be raised. The motor operating the capstan is capable of furnishing a normal of 8.8 horsepower. The speed of the motor is 1,250 revolutions per minute, corresponding with a hoisting speed of 32 meters (105 feet) per minute, with a load of 500 kilograms (1,102 pounds). When necessary, the speed may be increased to 2,500 revolutions per minute, corresponding with a hoisting speed of 64 meters (210 feet), with a load of 250 kilograms (551 pounds). The starting device is placed beside the capstan, and carries a brake acting upon the shaft of the motor and permitting the descent of the load to be carefully regulated. This starting device is similar to that of the motor operating the screw propeller; that is to say, it acts by means of a current from the generator, and permits a variation of speed from zero to a maximum in either direction.

All the electric connections between the separate pieces of apparatus and machines are carried in cables of lead, which are proof against moisture. The complete electric equipment has been installed by the Company of Electric and Mechanical Industry of Geneva.

1,000-Ton Self-Trimming Barge.

The plans reproduced on this page and the one following, are those of a "self-trimming" barge specially designed by one of our correspondents for the coal-carrying trade; and although, taken in the abstract, few of the features may be said to be absolutely



INBOARD PROFILE AND DECK PLAN OF SELF-TRIMMING BARGE.

original, the design as a whole is worthy of special consideration, both from a standpoint of efficiency as well as from an economical point of view in the handling.

The scantlings throughout are of mild steel considerably in excess of those required to meet the demands of any classification society from which a rating would be sought, but it should be remembered that the hard usages to which such crafts are generally subjected make it a matter of necessity to discard the question of initial cost in order to secure permanent efficiency, which in such cases is of paramount importance to the owner. And, unless due care is exercised in a judicious repartition of the weights as well as proper attention paid to the question of fastenings, the excessive strains such vessels are called upon to withstand, either when afloat or more often when aground, are liable to develop weaknesses and structural defects which subsequently become a constant source of expense to those who own them.

In this particular case every effort has been made to simplify the construction, at the same time retaining the maximum of efficiency. The web frames, as shown on the midship section, form a complete transverse tie from side to side, being fitted in conjunction with through beams (twelve in number), as indicated on the sectional elevation.

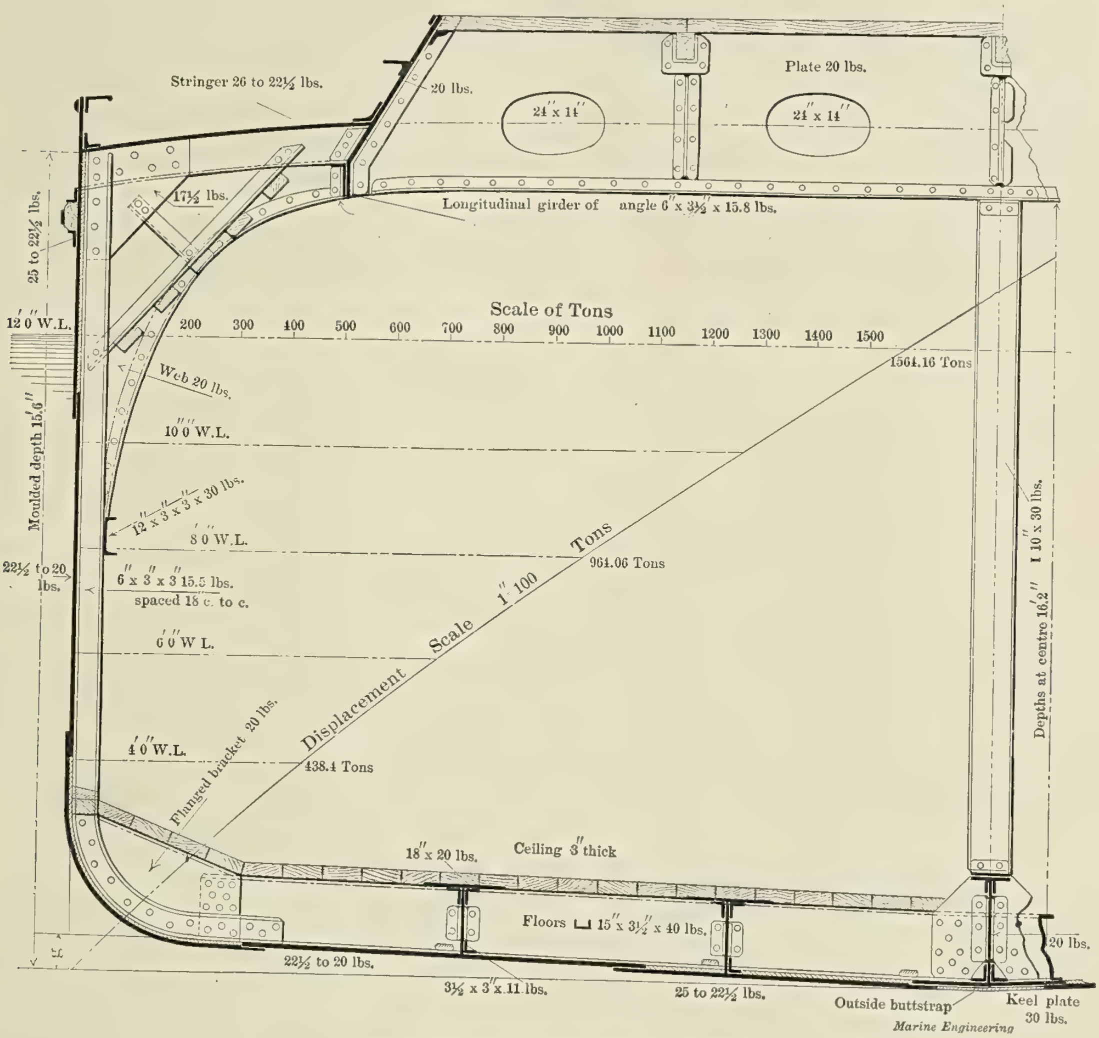
The floors, of channel section, 15 by 3½ by 3½ inches by 40 pounds, are in one piece from the middle line to the lower turn of the bilge, where they are connected to the frames by substantial bracket plates. Two intercostal girders, formed of 20-pound plates and angles, are fitted on each side between the center keelson and bilges, and these girders are completed, as an important item to resist longitudinal strains, by a continuous rider plate 18 inches by 20 pounds riveted to the upper angles and the top of the floors, as well as to the bottom shell plating, to which they are connected by 3½-inch clips.

The center keelson is continuous and forms the backbone of the vessel; and, in order to avoid joggling the lower keelson bars, the flat plate keel, which is of 30 pounds weight per square foot, has been fitted as an "inside strake," and the butt strap (treble riveted) fitted outside in one piece.

Substantial pillars of I-section, 10 inches by 30 pounds, are fitted at the middle line under each of the through beams, and form a strong tie between the bottom of the vessel and the deck beams.

A further reference to the plans will show that the hold, from bulkhead to bulkhead, has been left entirely free for the cargo, which may be poured in indiscriminately or removed by the most modern methods generally employed in such cases, without hindrance or loss of time. This barge will carry about 1,080 tons on 12 feet mean draft of water. The hatchways (three in number), 31 feet 6 inches by 22 feet, are such as to be convenient for any kind of freight, and if coal or any other bulk cargo is carried the "wing-boards" fitted at the sides are intended to avoid the possibility of such cargo ever shifting in a rolling sea, as well as the expense of trimming.

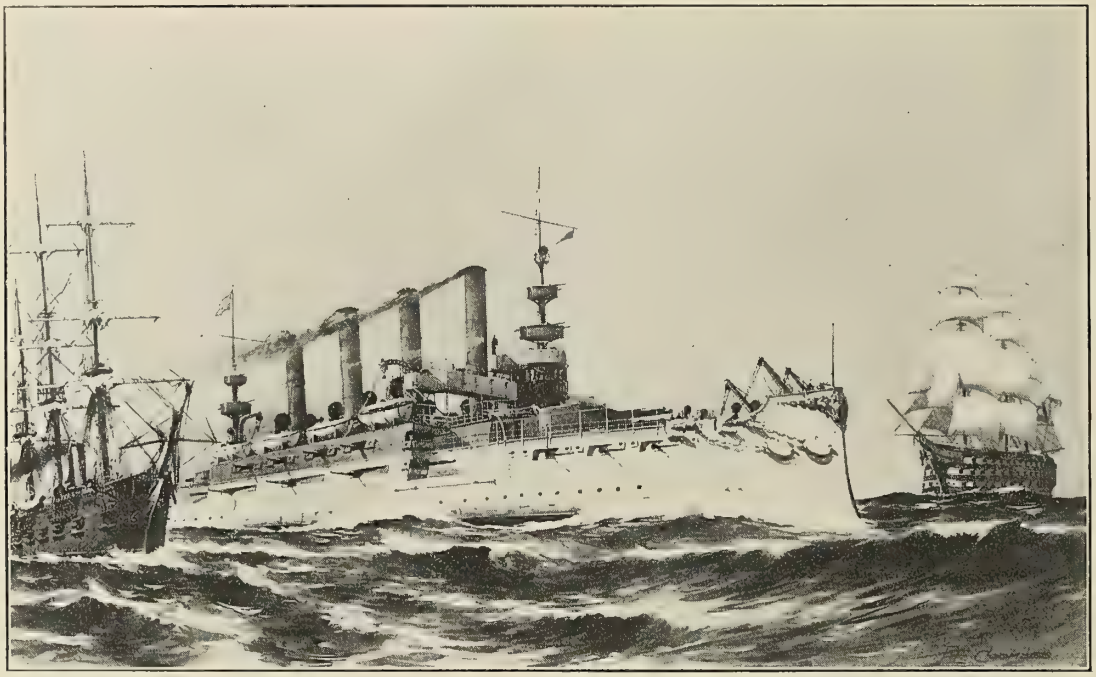
H. W.



MIDSHIP SECTION OF SELF-TRIMMING BARGE.

Mr. Hollis Burgess has succeeded Burgess & Packard in a yacht brokerage business at 10 Tremont street, Boston.

Mr. T. S. Marvel, shipbuilder, of Newburg, N. Y., has formed the T. S. Marvel Shipbuilding Company, and will continue the business under that name.



THE THREE UNITED STATES SHIPS PENNSYLVANIA.

Three Generations of the Pennsylvania.

We present on this page a reproduction from a drawing, showing three ships which have at different times been carried on the list of the United States Navy, all of which have been named *Pennsylvania.* The successive transition from the old sailing ship of nearly a century ago to the steam frigate of the time of the civil war, and then to the armored cruiser of the present day, is much greater in the actual fighting qualities of the ships than in the appearance, great as that is.

The first of these three ships was the first and only three-decker built for the United States Navy, and is said to have been the largest ship built in this country prior to the civil war, her displacement having been 3,241 tons. Built in Philadelphia in 1837, she was manned by a crew of upward of 1,100 men, and had a

THE ARMORED CRUISER PENNSYLVANIA, IN THE DELAWARE RIVER.

(Copyright, 1905, J. W. Dawson, Philadelphia.)

battery of no less than 120 guns. She was too cumbersome to be used on ordinary cruises and, as the result, made only one in the service of the country. In 1861, when the Union forces burned the navy yard at Norfolk, to prevent its falling into the hands of the Confederates, this ship was among those destroyed.

The second ship of the name was started in 1864, at the works of Harrison Loring, in Boston, and dragged along for several years, but was never completed, or even launched. The machinery was under construction at the Boston Navy Yard. This ship was one of a class of eight vessels, measuring 312 feet 6 inches in length by 46 feet in beam; her displacement was 3,953 tons, while the gross tonnage was 3,177. The ship was originally known as the *Kewaydin,* the name being changed to *Pennsylvania* in 1869, and the ship condemned and sold in 1874.

One of the *Georgia* class of battleships now under construction was given the name of *Pennsylvania,* but before the ship was actually laid down the name was transferred to one of the armored cruisers authorized just after the war with Spain. This cruiser, which has recently been placed in service, has a displacement of 13,680 tons and a speed of 22 knots. The length is 502 feet, beam 69 feet 6 inches, and draft 24 feet 6 inches. The battery consists of four 8-inch and fourteen 6-inch rifles of the rapid-fire type, together with nearly fifty smaller guns. She was built by the William Cramp and Sons' Shipbuilding Company, in Philadelphia.

ARMORED CRUISER PENNSYLVANIA, IN DRY DOCK.
(Copyright, 1905, J. W. Dawson, Philadelphia.)

A Type of Army Vessel.

The accompanying photograph shows one of two sister ships completed last year by the Pusey & Jones Company, of Wilmington, Del., for the quartermaster's department of the United States Army, namely, the *General Nathaniel Greene* and the *General Thomas S. Jesup.* Their principal dimensions are:

	Ft.	Ins.
Length on deck	130	0
" " load water line (9-ft. draft)	123	4
" (American Bureau)	119	0
Breadth, molded	27	0
Depth, "	12	4
Displacement (9-ft. draft), including 70 tons of feed water, coal, and cargo	428 tons	

They are staunch little vessels, built under special survey of the American Bureau of Shipping, and designed for a speed at load displacement and under natural draft of 13 statute miles per hour. Both steamers were finished within contract time, and maintained a speed for a continuous run of four hours of over 13.2 miles per hour, with allowance for tide. The trials were run on the Delaware River and the tide factor was eliminated in the following manner: An endurance run was first made over a measured course of 26 miles and return without stop. This was to be covered in four hours. The usual gauge, temperature, and revolution counter readings and cards were taken every fifteen minutes. Both vessels made this run with some minutes to spare, but it was not considered that steaming half way with the tide and the other half against the tide satisfactorily eliminated the tide factor. So three pairs of standardization runs were made over a measured mile course, the first at a high steam pressure, the second at an intermediate steam pressure, and the third at a steam pressure low enough to insure the speeds being below thirteen miles per hour. The principal readings on these runs were the elapsed time and the total revolutions for that time. The average speed per hour and revolutions per minute for each pair of runs was then calculated and a curve laid off with the former as one ordinate and the latter as the other. Then the average revolutions per minute for the entire endurance run was found and spotted on this curve. The speed corresponding to this number of revolutions as determined by the curve was taken as the actual speed of the vessel on her four-hour run.

The engine is a vertical inverted compound with cylinders 20 and 40 inches diameter and a stroke of 24 inches. It is constructed in accordance with the most up-to-date practice, with a built-in condenser, independent air pumps, and box guides. Steam is supplied by two Scotch boilers 9 feet 9 inches inside diameter

A NEW ARMY STEAMER.

and 10 feet 6 inches over heads, at 150 pounds working pressure. Each has two corrugated furnaces with 33 square feet of grate surface, and each boiler has 1,003 square feet of heating surface. The cast-steel propeller is of the four-bladed built-up type, 8 feet 4 inches diameter and 11 feet 3 inches pitch, right-hand, true screw. The pitch can be adjusted from 10 feet 1 inch to 12 feet 5 inches.

The general arrangement of the steamer may be briefly outlined as follows:

Beginning at the stem, there is a trimming tank extending to the deck and 9 feet 5 inches fore-and-aft, with a capacity of 8 tons of water. Aft of this is the forecastle, 10 feet 8 inches long, with accommodations for seven men. The chain locker and a store room are underneath the forecastle, access to both being obtained from the fore hold. This latter is 26 feet 3 inches long. At its after end is placed a four-drum steam hoisting engine with levers on deck for operating the six-ton cargo boom shown in the photograph. There are two 14-inch diameter drums for the hoist and topping lift and two 12-inch diameter drums for the range port and starboard. Under the wood ceiling of the hold for 14 feet 3 inches forward of the boiler-room steel bulkhead is a built-in boiler feed tank of fifteen tons capacity. A 400-gallon galley tank is located near the hoister.

The boiler room is 33 feet 3 inches long; the boilers are arranged fore-and-aft with the fire room between them and coal bunkers of 90-tons combined capacity port and starboard. A steel bulkhead separates the boiler and engine rooms and to its after side are fastened a number of the auxiliaries. The engine is handled from below on the starboard side, and on this side is also located the electric plant, consisting of a 7-Kw. direct-connected marine generating set. The electric equipment includes a 13-inch searchlight. From the aft boiler-room bulkhead to the after-peak bulkhead is a distance of 28 feet, and just forward of the latter are rooms for the engineers, port and starboard, well fitted up, and with one berth each. From each room a ventilator leads to the upper deck. The engineers' work bench is against the bulkhead and between the two rooms. The capacity of the after-peak tank is 8 tons, and it is limited by a watertight flat 4 feet below the main deck, which allows of ready access to the quadrant, and provides stowage for the spare tiller, etc.

The deck house is of steel, its total length forward and aft at the center line being 82 feet 7 inches. This leaves 43 feet 5 inches deck room forward and 4 feet aft, with a passage around the after part of the house as shown. A wooden bulkhead aft of the after gangway separates the officers' cabin from the rest of the house, and a separate toilet room is provided for them behind it. The steel engine and boiler casing, 35 by 11 feet, starts 17 feet 6 inches from the forward end of the house, with the galley and mess room over the after boiler. The crew's toilet room is just forward of the aft gangway on the port side of the ship. Seats are arranged along both sides of the midship house except in way of the coal ports shown in the photograph. Coal is led from these to three 20-inch deck scuttles through portable iron chutes.

In the engine and boiler casing and at its after end are stairways leading to the upper deck, whose general arrangement can be clearly seen. Three of the lifeboats are 22 feet long and one 16 feet long. In the pilot house is a combined steam- and hand-steering gear having one wheel, 5 feet 6 inches diameter, for both, and connection is made by shafting and bevel gears to a steam-steering engine on a raised platform just forward of the engine and boiler casing. The captain's state room is aft of the pilot house. The air ports in the hull are 8-inch clear glass, the two forward ones in the forecastle being hinged to open. In the front of the house are six 15-inch air ports.

The equipment includes two stockless anchors and 110 fathoms of chain. The windlass is of the tub-boat type with double cast-iron bitts. Awnings are provided for the upper deck and for the main deck forward. On the latter the cargo boom acts as a ridge pole. As can be seen from the foregoing, everything about these steamers is arranged with an eye for the greatest convenience and practical utility, and it is not often that the needs and possible requirements of a boat of this type are so fully provided for.

H. H. T.

French Shipping.

The French merchant marine continues to suffer acutely from an apparently insuperable difficulty—lack of outgoing freight. In Marseille, for example, decidedly the most important French port, against 4,666,198 tons of goods imported during 1903, but 2,170,212 tons were exported. Added to this vital complaint of ship owners is the increased cost of operating French ships compared with those of other nations, and, by no means least of all, troubles with labor.

The statistics of the port of Marseille continue to demonstrate the increasing sea power of the smaller maritime nations operating cheaper ships with cheaper men than either Great Britain or France. While the amount of merchandise landed and shipped from Marseille from 1900 to 1903, inclusive, increased by 936,335 tons, French ships benefited by only 163,252 tons of increase and British ships by only 89,726 tons. During the same interval the freight going out and coming in on ships of other foreign nations increased by 683,357 tons. Three Mediterranean nations show increases in the last three years greater or almost as great as those of Great Britain or France, namely: Italy, 183,000 tons; Greece, 199,208 tons, and Spain, 142,318 tons.—*Daily Consular Report.*

MOTOR BOATS.—(Continued.)

BY DR. WILLIAM F. DURAND.

THE MOTOR-BOAT ENGINE.

The problem of the engine, or of the motive power, as already outlined in the introduction, will involve questions of weight and space, economy, simplicity, reliability, adaptation, and cost. In addition to these general considerations and in a more detailed way there will be questions of proportion, size, and form, of material and workmanship, of carburetion and ignition, of lubrication and wear, and, in short, of the many points of detail which lie between the engine as it exists in the mind of the designer and in the boat of the user. The general structural arrangement of the marine internal combustion motor of the two-cycle type is well indicated in Figs. 18 and 19, showing sections through an engine of the *Western* design, while in Fig. 20, showing a section of an engine of "Standard" design, the general arrangement of a single-cylinder four-cycle engine is likewise indicated. In either case multi-cylinder engines will require, of course, only a reduplication of similar units. An examination of these cuts in connection with the discussion of the operation of the two- and four-cycle type of engine, as found in the introductory chapter, will serve to make clear the function of the various parts here shown, and also to still further illustrate the same general principles and theory of operation. The cuts further illustrating the present article, and drawn from representative examples of modern design, will also serve to illustrate many general points of arrangement and design outside of those to which direct reference may be made.

Weight. Turning now to some of the special features which go to make up the problem of the engine, we find weight standing near the top in point of importance. This question has already been touched on in connection with the general discussion of the two- and four-cycle types, and it will be remembered that with the same general schedule of design the four-cycle type will be somewhat heavier than the two-cycle. Pursuing this comparison with reference to some further points of structural detail, it is clear that with the two-cycle engine the necessity of inclosing the crank case will involve a certain amount of weight which is saved in the four-cycle type, and the latter may in consequence be made sensibly lighter per cylinder so far as columns and bedplate are concerned. On the other hand, the four-cycle type must be made somewhat heavier in its valve gear and flywheel. The difference due to these items, however, will scarcely balance the relative gain due to crank case, and it thus results that per cylinder and on the same general schedule of design the four-cycle type may be made somewhat lighter than the two-cycle. On the basis of power the two-cycle type scores its most important advantage by reason of the double number of power strokes in a given time, and in consequence of which (with all other conditions the same) the power developed in the two-cycle type would be twice that in the four-cycle. This advantage is discounted, however, by the higher revolutions practicable with the four-cycle type, and by the somewhat higher thermodynamic efficiency of its cycle, as already noted.

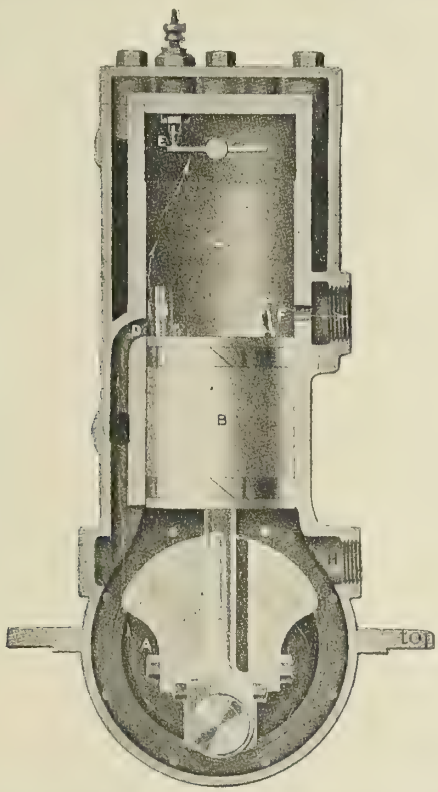


FIG. 18.—SECTION OF "WESTERN" TWO-CYCLE ENGINE.

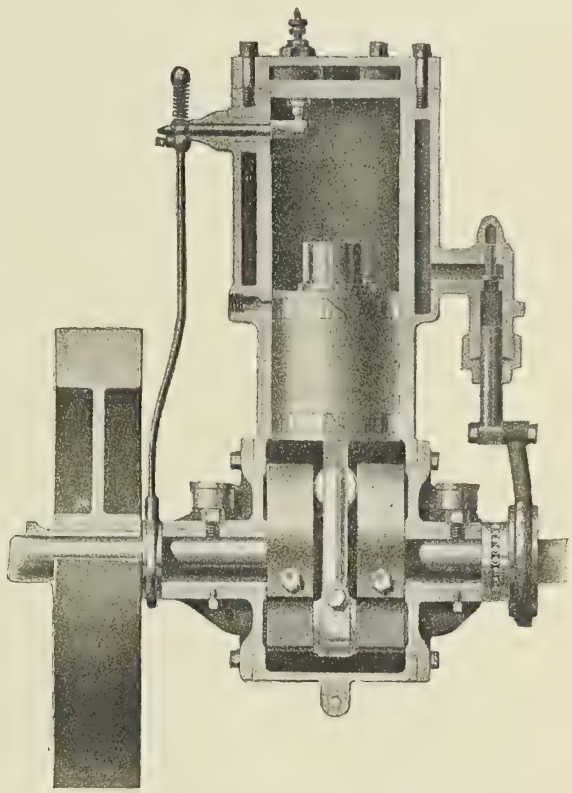


FIG. 19.—SECTION OF "WESTERN" TWO-CYCLE ENGINE.

On the final power basis these various relative gains and losses are likely to leave the advantage slightly with the two-cycle type, comparing on the same general schedule of design. So far as actual practice goes, however, the four-cycle type scores a signal advantage in having attracted much more attention and study on the part of engineers and skilled designers, especially for engines of moderate to large power. It thus results that in the best practice of the day with four-cycle engines, every advantage is taken of special materials and of their most economical disposition and use, and all in such manner as to realize the needed strength on the minimum of weight and space. Large engines, furthermore, gain in economy of weight per unit of power, so that with the best practice of the day, four-cycle engines in typical sizes, or from 10 to 100 horsepower and upward, are very much lighter per unit of power than two-cycle engines, also in typical sizes, or from 2 to 10 horsepower.

Between the two types of engine there is, after all, but little contest so far as possession of the field is concerned. For engines of moderate to large size, and where economy, reliability, and durability are of importance, the four-cycle type must be conceded to be typical; while on the other hand for small sizes, and where

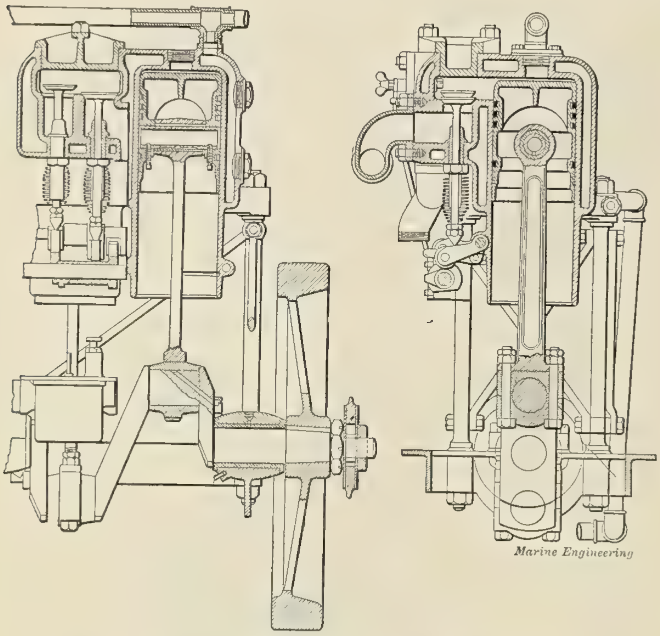


FIG. 20.—SECTIONS OF "STANDARD" FOUR-CYCLE ENGINE.

compactness, simplicity, and low first cost are of importance, the two-cycle type may properly claim full recognition.

In moderate or large sizes, or from 10 horsepower to 100 and over, four-cycle engines are quoted from an upper range of 60 or 80 pounds down to 10 pounds or less per horsepower, lighter as the size of the unit increases, and according to the style of design. To a certain extent there is coming to be a differentiation in the field of design into common and so-called "auto" or high-speed practice. In the latter the weights may be expected to vary from perhaps 20 pounds per horsepower down to 10 or less, while in the former the ordinary range is found perhaps between 40 and 80, or even up to 100 and over in small sizes. For two-cycle engines the weights in sizes from 1 to 5 horsepower are found usually between 50 and 100 pounds per horsepower.

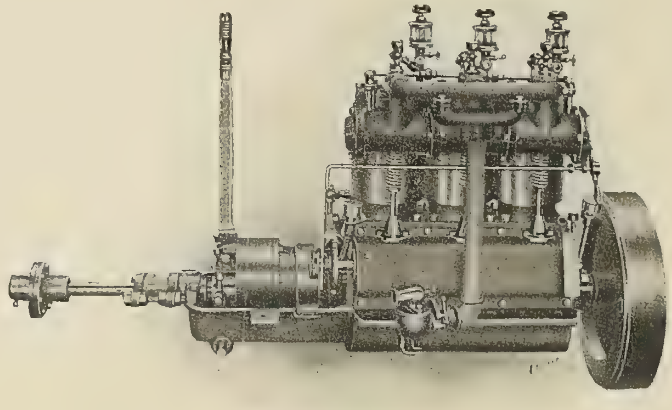


FIG. 22.—THREE CYLINDER, FOUR-CYCLE "LAMB" ENGINE, STARBOARD SIDE.

These figures again illustrate the fact above noted that the field of operation is fairly well divided between the two types, the two-cycle being found only in small sizes, and the four-cycle being restricted for the most part to medium and large sizes; and that while on the same schedule of design and in the same sizes the two-cycle engine may be made somewhat lighter, actually the lighter constructions are in the four-cycle type because the schedules of design and the sizes are not the same, and the four-cycle type gains in marked degree both by reason of its size and the special design in which such engines are made when high speeds are desired.

In quoting the weights of engines there is much diversity with regard to including the weight of the flywheel. It is clear that with so considerable an item either omitted or included, a very considerable difference will result in the weight, and in order to properly interpret any given figures it should be definitely known whether they include the flywheel or not. Since it is a necessary feature of the operation of the engine it should, of course, be included.

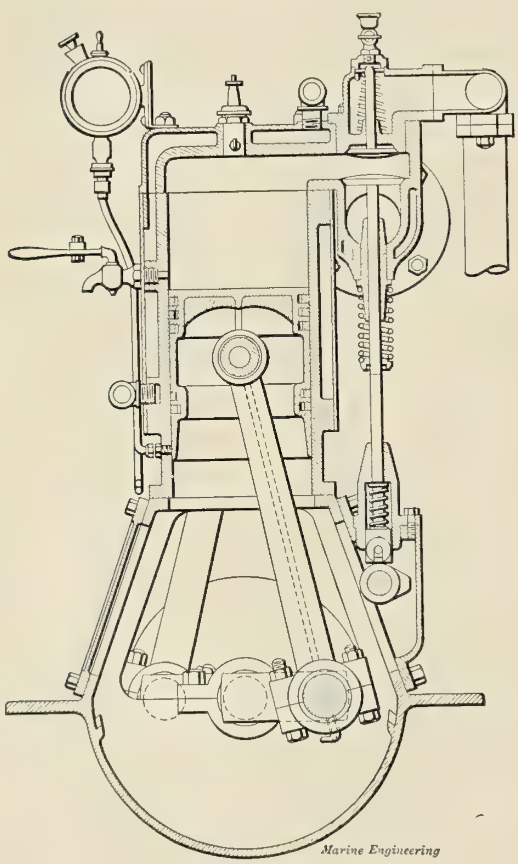


FIG. 21.—SECTION OF "LAMB" FOUR-CYCLE ENGINE.

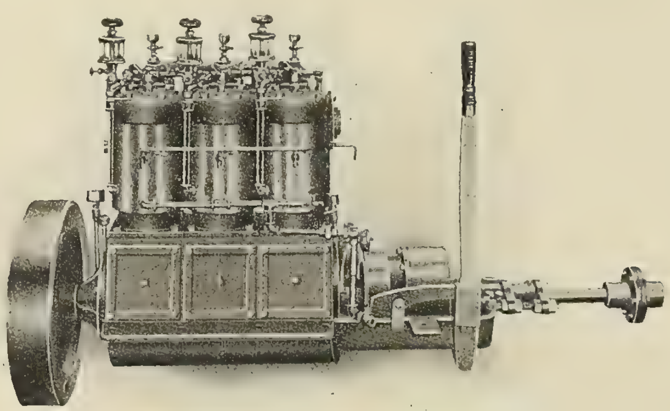


FIG. 23.—THREE CYLINDER, FOUR-CYCLE "LAMB" ENGINE, PORT SIDE.

Details of Design. The limits of the present series of articles will not permit of any general discussion of the problem of design. There are, however, certain special points to which brief reference may be made.

We first note, as shown in the various cuts, that the typical marine internal combustion engine is of the single-acting type with half-trunk piston, thus avoiding the use of the usual crosshead connection between piston and crank. This mode of connection, as well as the need of broad rubbing surfaces, gives to the piston its typical form, so distinctly different from the shallow piston employed in the common type of steam engine. This again leads to the long cylinder bore met with in all engines of this type. The relation between stroke and diameter is very commonly one to one, while occasionally the stroke is slightly greater than the diameter. The actual length of cylinder, however, including the length of piston and length for the clearance in which the gases are compressed, is very commonly between two and three times the diameter of the bore.

In the two-cycle type the frame and bedplate are very commonly cast together with the cylinder, the casting containing likewise the inlet and exhaust passages and cylinder-jacket space. In the four-cycle type the cylinder frame and bedplate are also in some cases either cast together or are constructed of cast metal mounted up as a solid structure, and as shown in several of the illustrative cuts. In other cases, where saving of weight is of importance, the framing is made of light steel columns, very similar in style to the so-called torpedo-boat type with the steam engine, and as shown in Fig. 27.

The form of the piston has already been referred to. In all first-class designs special attention is given to the piston packing. Usually two sets of spring rings are fitted, one set near each end, and two or three rings in each set. Leaky piston rings, in addition to the direct loss by leakage on the power stroke, seriously disturb the operation of the engine by preventing proper compression, and thus interfering with the efficiency and completeness of combustion. For these reasons the piston packing is a matter of serious moment, and one to which designers and builders must give special care, and users must endeavor to maintain by careful lubrication and general watchfulness.

In the matter of the moving parts generally, modern practice has made great advances, both in form and proportion and in the materials employed. Large power on small weight means special care in the disposition of material, and special provision in the size and proportion of joints and rubbing surfaces. A comparison between the sizes and proportions of the crank pins and main shaft bearings under present conditions, and those prevailing in the practice of a few years ago, will show one of the principal means by which the present extreme results are obtainable. Special bronzes of tensile strength running to 70,000 or 80,000 pounds per square inch, and special steels running to 140,000 or 150,000 pounds, are used for rods and shafting, especially in the leading European practice with designs for forced output.

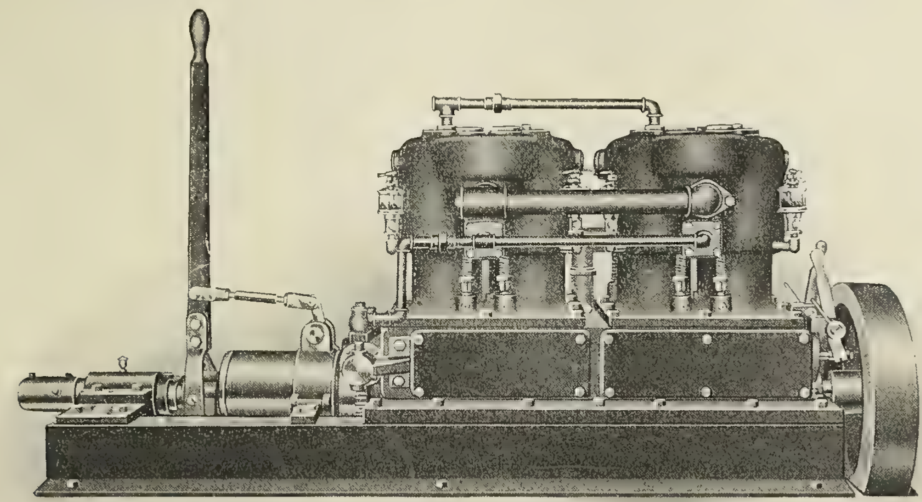


FIG. 25.—FOUR CYLINDER, FOUR-CYCLE "EAGLE" ENGINE.

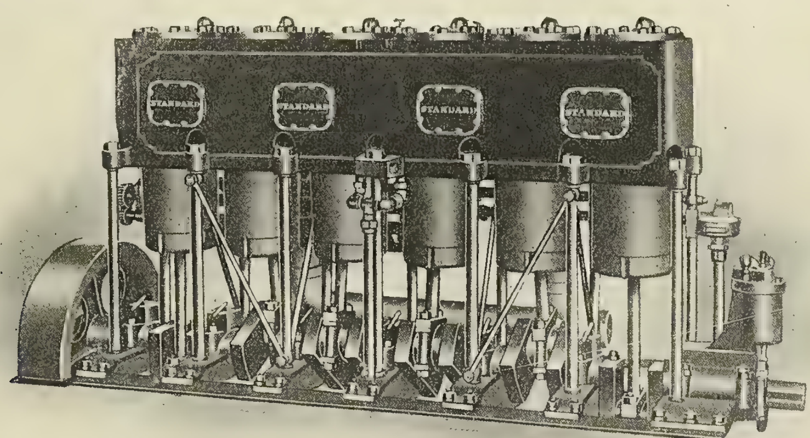


FIG. 26.—SIX CYLINDER, FOUR-CYCLE "STANDARD" ENGINE.

Turning to valve gear, in the two-cycle type there are no valves for distribution to the engine, and only such valves are required as may serve to control the supply of gasoline to the carburetor, or to serve as throttle between the latter and the crank case. This item makes for simplicity and is one of the principal features tending toward lower first cost in this type of engine. In the four-cycle type each cylinder must be fitted with an inlet and an exhaust valve. These are commonly of the disk or poppet form and are usually of about the same size and in some cases interchangeable. The inlet valves are made either

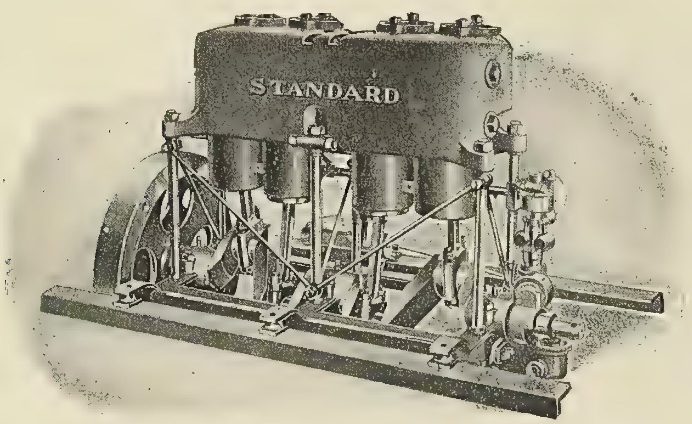


FIG. 24.—FOUR CYLINDER, FOUR-CYCLE "STANDARD" ENGINE.

automatic in operation or driven by a suitable gear. The automatic valve operates in manner exactly similar to the valve of an ordinary pump, opening when the pressure within the cylinder falls below that within the carburetor, and closing when it rises above. For moderate revolutions such mode of operation will be found entirely satisfactory, but for distinctively high speeds the positively driven valve will be found more definite and satisfactory in its action. The general type of positively-driven gear consists of a revolving shaft geared down so as to make one complete

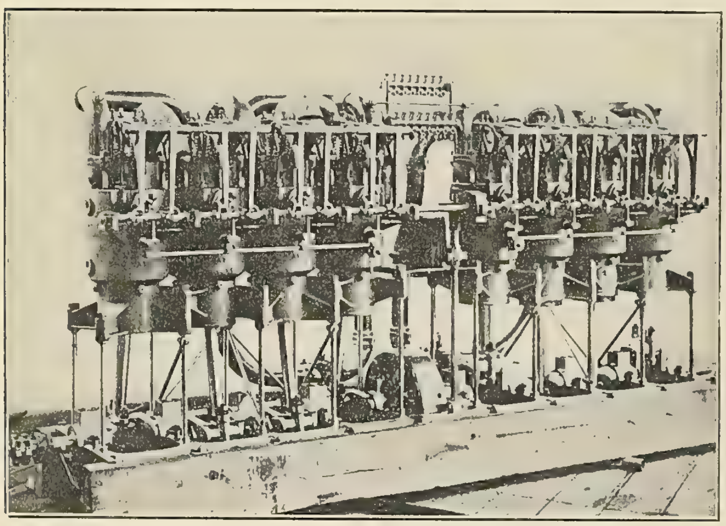


FIG. 27.—EIGHT CYLINDER, FOUR-CYCLE "CRAIG" ENGINE.

revolution for two of the engine, and carrying cams suitably arranged for the operation of the valves. One shaft may thus be used for the operation of both the inlet and exhaust valves. In the best practice water jackets surround the valve chambers and valve-stem guides, thus preventing overheating and insuring a smooth and easy working valve. The valves should be readily accessible for examination or renewal, and this requirement is usually realized by placing them in pockets covered by removable bonnets or caps. A typical arrangement of valves and valve gear with automatic inlet valve may be further illustrated by the section of Fig. 20, and a careful examination of this figure will sufficiently illustrate the main features of this general type of gear.

Regarding the item of thrust bearing, the ball bearing form for small and moderate sizes has received favorable notice, and has gained a definite status in the practice of the day. In larger sizes special forms of roller bearing are employed to some extent, while the familiar form of ring and collar thrust is still preferred by most designers.

(To be continued.)

Registration of Trade-Marks.

Renewed attention to the protection of trade-marks has been directed by a new law, passed by Congress at its last session, which by its terms became effective April 1, 1905. The provisions of this law are very favorable to manufacturers who register their marks at the United States Patent Office, and a large number of manufacturers using trade-marks have already applied for registration of their marks under it. Registration under the old law could be obtained only for those trade-marks which were used in commerce with foreign states or the Indian tribes; and, in addition, many trade-marks which had been used for years and had become of great value were denied registration because of technical objections.

The new law provides for registration of trade-marks that are used in commerce, not only with foreign nations and Indian tribes, but also *between the states.* It likewise contains a new and valuable provision to the effect that all trade-marks in the exclusive use of the applicant or his predecessors in business for ten years preceding the passage of the act (February 20, 1905), may be registered. This provision is intended to permit the registration of marks to which otherwise technical objections might be made, and was particularly framed for the better protection of "old marks."

The government fee for registering a mark has been fixed at $10. This is a substantial reduction from the former fee, which was $25. The registration remains in force for twenty years, and may upon application, made not later than six months before the expiration of the term, be renewed for a like period.

Privileges of registration are extended to those aliens whose countries afford similar privileges to citizens of the United States. The following foreign countries have trade-mark treaties with the United States: Austria-Hungary, Belgium, Denmark, France, Germany, Great Britain, Italy, Japan, Russia, Servia, and Spain. The laws of Switzerland and the Netherlands are similar to our own in limiting registration to those aliens whose countries afford similar privileges to the citizens of those countries.

It is required of aliens, however, that they shall first have registered the mark in their own country before being entitled to registration here.

Section 5 of the new law specifies certain marks not entitled to registration. These are: those containing immoral or scandalous matter; those containing the flag or coat of arms of the United States, or of any state or foreign government, or any simulation thereof; those conflicting with a known or registered mark applied to goods of the same descriptive properties; those consisting merely in the name of an individual, firm, etc., unless printed or woven in some particular or distinctive manner, or used in connection with a portrait of the individual; those consisting merely of the portrait of a living individual unless with his written consent; those descriptive of the goods, their character or quality; those consisting merely of a geographical name or term.

Marks already registered under the old law must be reregistered under the new law to become entitled to its liberal provisions.

Mr. J. R. McColl, associate professor of steam engineering at Purdue University, has resigned his position for one in the engineering department of the American Blower Company, Detroit.

A National Motor Boat Carnival.

It is announced that a motor boat carnival, under the auspices of the National Association of Engine and Boat Manufacturers, will be held on the Hudson River on September 14, 15, and 16. The start will be at a point opposite Ninety-seventh street. The iron steamboat *Sirius* has been chartered for the use of members, guests, and officials.

The carnival will consist in races for boats of various classes, all of which must be propelled by either hydro-carbon or electric motors. The classification into which the boats are divided are high-speed motor boats, cruisers, and open launches. Under the first heading are subdivisions, of which the first includes all boats not over 40 feet in length; the second includes all boats over 40 feet; and the third all boats under 33 feet. Under the second division there are two classes, separating at a length of 50 feet, while the open launches are all to be under 50 feet in length. Applications for entry blanks and other information should be made to Mr. Hugh S. Gambel, secretary, 314 Madison avenue, New York city.

New Austrian Torpedo Craft.

The Austro-Hungarian government has evolved a new scheme in the standardization of machinery for torpedo boats and torpedo boat destroyers, having recently let a contract to Messrs. Yarrow & Company, of London, for one ship of each class, which are to be used as patterns for future construction in Austrian naval yards. The destroyers have a displacement of 390 tons, and the speed will be 28 knots when the engines are developing 6,000 horse power. The torpedo boats will be of the first class and will displace 200 tons. With 3,000 horse power, a speed of 25 knots is anticipated.

The main point of interest, however, is that the machinery of the two classes will be interchangeable, because of the fact that the destroyers will have twin screws, each actuated by an engine of 3,000 horsepower, while the entire power in the torpedo boats will be used to operate a single screw. This will enable the naval stations to carry a much smaller supply of spare parts than would be the case if these engines were not all of the same size, and will much facilitate repairs and renewals whenever these are found to be necessary. It is intended to make this fleet at present consist of 12 destroyers and 36 torpedo boats, of which the first in each class is to be built in London, as mentioned above.

Warm Work.

Editor MARINE ENGINEERING:

Some years ago, while serving as an engineer on an Atlantic liner, I was early one morning called on to do an emergency job. A fusible plug had blown out on top of one of the combustion chambers. The boiler had two furnaces, with a combustion chamber common to both, and was one of a battery of eight.

When I arrived on the scene the two fires had been drawn, the boiler partly blown down, and the steam let off, and for my comfort a bed of waste matting laid on the fire bars. I crawled in on the matting and commenced tapping the defective plug for the reception of a brass bolt. Standing in the back connection I had just got started when I saw the furnace full of matting on fire. Crowded against the back wall I stood for a few seconds and watched the flames rush toward me, turn upward and dart through the tubes; then thinking a little fresh air would do me good, I got out through the other furnace, burning my hands severely on the bare grate. When the fire had burned itself out and some boards been laid on the grate I went in again and finished my job. Although at that time evidently too green to burn, I was impressed with the danger of going into a tight place on an inflammable bed, and never did it again. W. CUTHBERT.

The Disaster to the Bennington.

At about 10:15 A.M., July 21, the United States gunboat *Bennington,* which was preparing to get under way in the harbor of San Diego, Cal., suffered a disastrous catastrophy in the explosion of one of her boilers and the liberation of the steam from the other three. The force of the explosion did great damage to all parts of the vessel, and broke sea valves and pipes so that water came in and the ship began to list badly, and was finally run aground in shoal water. The list of casualties, as given out by the Navy Department, includes 62 dead, of whom two were officers, and in addition 14 were seriously and 26 slightly injured. This aggregates 102 of the entire crew of 197 men, and some of the remainder were slightly burned or scalded.

The *Bennington* had four cylindrical straight-away boilers, commonly known as low cylindrical or locomotive gunboat boilers. Each was 17 feet 9 inches long, with a diameter of 9 feet 9 inches, and the original design called for the carrying of 160 pounds of steam. It was a well-known fact, however, that the boilers were weak, and the last log received at the Navy Department shows that the safety valves were set at 145 pounds, and that the boilers were usually forced not above 135 or 140 pounds. They were fifteen years old, but had been retubed about eighteen months ago. The rear admiral in command of the Pacific fleet reported to the department last year that the boilers were in need of repairs, but that the matter was not urgent; while a report about the same time from the engineering officer of the ship showed that the boilers were generally in poor condition, but that their internal condition was supposed to be good. Temporary repairs on these boilers were made at the Mare Island navy yard last May.

The report of the court of inquiry into this disaster has just been published, although its substance was known. This report finds that boiler B of the *Bennington* exploded, partly because of its being subjected to an abnormally high pressure, and because the metal of the crown sheet of the furnace, and the bolts holding that crown sheet in place, had become excessively fatigued by the alternate expansion and contraction due to the extreme differences in temperature to which they had been subjected during their fifteen years of service. It does not appear that the shell of the boiler burst, all evidence tending to support the belief that the furnace burst inward, and that the water, being suddenly reduced in pressure below its boiling point at the existent temperature, suddenly flashed into steam in such quantities as to completely fill nearly every part of the vessel. To add to the quantity liberated by this means it is probable that steam from the other boilers was drawn through the common steam pipes connecting all boilers, and had a large share in causing the tremendous loss of life above noted. It appears from information at hand that the machinery, at the time the accident occurred, was in charge of an ensign who had had a little more that six months' engineering experience; and this, in a ship which had formerly carried a chief engineer, a past assistant engineer, and an assistant engineer. There was no warrant machinist on board, and, indeed, no such official has ever been attached to the *Bennington,* and it goes without saying that no engineer of the old corps was available for service on the ship.

The *Bennington* is described as a steel unarmored gunboat with a displacement of 1,700 tons, a length of 230 feet, a beam of 36 feet, and a draft of 14 feet. The machinery consisted of the four boilers above mentioned, which had an aggregate grate surface of 220 square feet, and a heating surface of 8,210 square feet; and twin-screw, horizontal, triple-expansion engines with cylinders measuring 22, 31, and 50 inches in diameter, and a stroke of 30 inches. This machinery developed on trial about 3,400 horsepower, and gave the ship a speed of 17.5 knots.

We are commenting editorially upon this disaster and its causes.

Messrs. Lorillard & Walker, of 41 Wall street, New York, have succeeded Mr. Frank N. Tandy as yacht broker in New York and Boston.

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The Disaster to the Bennington.

Since the beginning of things in the United States Navy, there has been, with possibly one exception, no accident comparable with that which overtook the *Bennington,* late in July, in San Diego harbor. The exception to which we refer was the terrific explosion of a new rifled gun on the United States ship *Princeton,* in 1844, as the result of which a large number of men were killed and others injured, the death list including an unusually large number of distinguished officials, among whom were the Secretary of the Navy and the Secretary of State.

It is impossible to attribute the cause of the present disaster to negligence on the part of anyone connected with the ship. The ensign who was in charge of the machinery at the time of the explosion had had an utterly insufficient amount of experience in connection with engineering work; but his position on the ship was the result, not of his own initiative, but of a system which, during the last six years, has well nigh destroyed the efficiency of the engineering corps of the United States Navy. In his last official report as Engineer-in-chief of the Navy, Rear Admiral Melville declared that the machinery of our naval vessels was deteriorating, and he attributed this declining efficiency to the Naval Personnel Act of 1899. He has recently been quoted as saying:

"There cannot be an efficient navy in any nation without an efficient engineer corps. Great Britain has the greatest and best Navy and the best engineer corps. Unfortunately for America, we have now no engineer corps, though we used to have the best in the world."

In his report, dated October 1, 1904, Rear Admiral Rae states:

"There is no doubt that an insufficient quantity of engineering duty has been performed by the younger line officers to properly qualify them for filling the higher engineering positions at sea. The cause is well known—a lack of officers. If no other way can be found, it would be to the advantage of the country to place out of commission the requisite number of vessels now in service, in order to obtain the officers for this vital necessity. The lack of experienced men is felt in a great many vessels, as shown by numerous reports received. There are several cases on record where the engineering departments of vessels have suffered materially on account of the utter unsuitability and inexperience of the men in the engineering force."

"A little knowledge" in the engine room is a dangerous thing; and the fact that a man has passed a creditable examination after a four years' course in the Naval Academy is not a sufficient guarantee that he will make an efficient engineer. The United States government requires that a merchant ship of 3,400 horsepower shall carry not less than three licensed engineers; while it may be assumed, from what we know of the matter, that *not a man connected with the engineering force on the Bennington would have been able to obtain a license.*

In an editorial in our issue for June, we called attention to the extreme importance of having trained and thoroughly competent men to look after the expensive and complicated machinery of our warships. A man whose whole life has been devoted to this service is none too well equipped for the arduous duties devolving upon the chief engineer on a modern warship, and the least that can be done by the officials in charge of the department, is to adopt some method by which competent men, and competent men only, shall be given positions of such responsibility. So long as conditions persist such as those existing prior to 1899, and seem to point to the conclusion that social qualifications and opportunities are of much more importance to the officers of the Navy than the proper performance of technical duties connected with the operation of the ships, and particularly of the machinery thereof, it will, we suppose, be utterly out of the question for us to expect a return to anything similar to the old engineer corps, which had proven its great efficiency in the day of trial and stress of war, and had demonstrated in every way its peculiar fitness for the work required of it. It is not, however, unlikely that Congress will see fit to make some change in the Personnel Law, which will tend to bring about results such as ought to obtain in the service. While it is a desirability that the engineering officer in charge of machinery should be well educated and have a good theoretical knowledge, it is an absolute necessity that he should be a practical engine driver and mechanic; and this can be acquired only by experience extending over years of practice.

The whole thing seems to point to the necessity of making proper provision in numbers, rank, and conditions of service for a corps of warrant machinists, or engineer officers under some other name, but performing the particular duties usually devolving upon warrant machinists, sufficient to take care of the engineer needs of the Navy in ships built and building, and to allow the necessary proportion of shore duty to these officers to render them perfectly contented with their position in the service. Our issue for June contained a communication from an engineer officer, not in the Navy, in which the present system was highly commended, though the lack of officers so far as numbers are concerned was greatly deplored; and that communication furnished the basis for the editorial in that issue to which we have above referred. There seems to be a general idea afloat in the minds of those in charge of things in Washington, and particularly in the minds of those who conceived and carried to enactment the Personnel Bill of 1899, that, as voiced by our correspondent above mentioned, the "Jack of all trades" is the proper man to put in charge of the engine room. In our editorial three months ago, we endeavored to show the fallacy of this point of view; and it is more than certain that the disaster to the *Bennington* forms a strong point in favor of our contention. While, as we have already said, the ensign in charge of the machinery at the time of the explosion cannot be held personally responsible for either the fact of the explosion or the conditions which led to that fact, it is none the less certain that his position on the ship was an entirely false one, owing to his being in a certain sense what we have referred to as a "Jack of all trades," and what is sometimes known by the concurrent expression, "master of none."

The engineer proposition in our Navy is a very live one, and one which demands not only the most careful attention possible to be given it by those in authority, but also immediate attention and action on the part of Congress to provide some suitable force for taking care of the machinery now exposed to what may possibly prove to be a series of accidents of which that to the *Bennington* is only the first. It cannot be too strongly urged that an efficient engineer corps is in many respects the strongest element conducing to an efficient navy, and that the system by which this corps is degraded and rendered almost impotent in face of danger by the methods now in vogue cannot be too strongly condemned. It is certainly as Admiral Melville says: "We have now no engineer corps, though we used to have the best in the world."

It is equally certain, however, that so long as the warrant machinist is kept in his present position, as regards opportunity for advancement to command rank, it will be utterly impossible to obtain in the service the very sort of men who ought to be there, namely: men whose education has been of such a character and extent as to enable them to properly fill the highest position to which such advancement might bring them. So long as no opportunities are offered which would be inducements to men of the character and education desired in the service, there will be little opportunity of improving the quality of the men accepting appointments as warrant machinists, and it is precisely these men on whom we will have to depend for the steaming qualities—and in large measure for the fighting qualities—of our ships, whenever they may be called upon to perform active duty. Not only this, but the number of such men in the service should be increased to at least two or three times the present allotment, in order to properly provide for ships now in service and under completion; for, as reports have stated, there are no warrant officers at present available for use on the small vessels of the Navy, nor will there, under present conditions, be any available, for a long time to come.

It goes without saying that, until we have a sufficient number of engineer officers of such intelligence and capacity as to be safely entrusted with the responsibilities of handling the great machinery plants of our ships, we cannot expect to be free from continual expense and trouble resulting from accidents, or to be fit in any sense to try conclusions with a power much inferior theoretically to our own.

Shipbuilding.

For the first time in many months the outlook in shipbuilding on the two coasts of the United States gives promise which is decidedly encouraging. Within the past four or five weeks there has been more done in this line in the way of contracts placed and ships started than was the case in the entire four years preceding. Important among the new ships started are two for the American-Hawaiian Steamship Company, which are to have a carrying capacity of 11,000 tons and are to be ready for delivery in eighteen months. There are also two steamers building in Philadelphia for the Ward Line, one building in Chester and Hoboken for passenger traffic between New York and Boston, another building on the Hudson for the Hudson River Day Line, and a large steamer building at Quincy, Mass., for the Southern Pacific Morgan Line, the latter being said to be the largest coasting steamer in America. Although all of these ships, with the exception of the two Ward Line steamers, are for what might be said to be essentially coasting trade, and the latter depart very little from our shores, yet the fact that so many contracts of such scope and character have been placed is exceedingly gratifying.

ABSTRACT FROM RULES AND REGULATIONS OF THE AMERICAN BUREAU OF SHIPPING FOR SOUND, LAKE, BAY, AND RIVER STEAMERS, YACHTS AND TUGS.

EDITION OF 1904.

ARRANGED BY HARRISON S. TAFT.

(*Continued.*)

(*b*) Vessels with a middle line plate keelson on top of floors, but not having the above intercostal plates, are to have wash plates of at least 3-16 inch thick fitted in lieu of said intercostal plates, extending all fore-and-aft. Said plates shall be clipped to the shell with single clips equal to the reverse bars.

3. HOLD OR SIDE STRINGERS. Also see Table 5.

(*a*) When worked in connection with hold beams (Table 5) the width of said stringer plates is to be not less than 2-3 that of the main deck stringer at corresponding frames, but of the same thickness. It may be 1-2 the width of the main deck stringer if of increased thickness, so that it shall equal 2-3 the sectional area of said stringer.

(*b*) When plate side stringers are worked in connection with web frames their width must be such that they will extend inside of the web frames so as to allow a continuous working of their face bar past said web frames; the vertical flange of the face bar being riveted to the reverse bars on the web frames without any diamond plate connection. The thickness of such a plate side stringer must be equal to that of a main deck stringer.

(*c*) A plate side stringer of the usual type is to be fitted midway between the upper bilge keelson and the main deck beams in all tug-boats fitted with web frames.

10. Floor Clips.

Angle clips equal to the reverse bars are to be fitted on top of all floors and on all frames in way of all angle stringers, plate stringers, etc.

11. Continuity of Keelsons.

All bilge and hold stringer continuous angle bars are to run from stem to stern, and be secured at their ends to breast hooks. They should be worked continuously through all web frames and watertight bulkheads, with watertight staple work at the latter.

12. Plate Side Stringers.

All plate side stringers are to be secured to the shell plating with single clips between the frames, except on a weather deck where the gunwale bar is to be worked continuously. A continuous angle bar is to be worked at the face of the frames on all lower deck and hold stringers, said bar being riveted to the reverse bars or to clips on the frames. All hold stringers should have a face bar fitted on the under side at the inner edge of the stringer plate. Gusset plates of the same thickness as the stringer plate should be fitted at all hold beams. Bracket plates supporting the stringer plate are to be fitted at alternate frames between the hold beams.

13. Web Frames in Lieu of Hold Beams.

1. In lieu of hold beams, web frames, spaced from 6 to 10 frame spaces apart, can be used. Said web frames are to be in depth at least 3 1-2 times the width of the flange of the frame bar to which they are attached and are to equal the thickness of same. Said depth is to be maintained at the junction with the floor plates. Double reverse bars are to be fitted at the inner edge of the web frame plating; but they need not exceed 3 inches by 3 inches by 7 pounds.

2. Vessels on the Great Lakes carrying bulk freight should have web frames not more than 16 feet apart; of not less width than stated above, but to equal the thickness of the floor plates.

14. Deck and Hold Beams.

TABLE 5.—SPACING OF DECK AND HOLD BEAMS. TYPE OF HOLD STRINGERS.

Depth from Top of Floors to Top of Lowest Tier of Regular Deck Beams Amidships.	Upper and Main Deck Beams.	Hold Beams.	Stringer Type.
12 under 15 ft.	On alternate frames.	......	[a] D A
15 " 18 "	" " "	......	D A + B P $\frac{3}{4}$ L
18 ft. and above.	" " "	[c] Every sixth frame.	[b] Plate.

D A = double angles riveted back to back. + B P $\frac{3}{4}$ L = with a bulb plate for $\frac{3}{4}$ length amidships.

[a] Located midway between upper bilge keelson and under side of said deck beam knees in one-deck vessels; but the ends of the deck beams in vessels with more than one deck.

[b] See "Hold or Side Stringers" under Section No. 9.

[c] Every tenth frame if extra heavy beams are used.

1. Deck beams in yachts can be from 25 to 30 percent lighter than otherwise if fitted on every frame.

2. When a steel deck, on which there is no wood decking, is less than 3-8-inch thick amidships, the deck beams are to be fitted at every frame.

3. Main deck beams are to be worked continuously through the top of a center-board trunk, with watertight staple work at same.

4. Fore-and-aft carlings at hatches are to be of the same scantling as the deck beams. Half-beams at hatches,

or at other deck openings, are to be of the same scantling as through beams, and are to be secured to the fore-and-aft carlings with double clips or forged knees.

5. When a beam is cut for a companionway a fore-and-aft carling with deck ties must be worked at said point; the same as for a hatchway.

6. Barges not fitted with propelling machinery, can have their main deck beams lighter than otherwise.

15. Beam Knees.

Said knees are to equal the thickness of the beam to which they are attached and are to be at least 2 1-2 times the depth of said beams on each side.

16. Deck Plating, Deck Stringers, and Tie Plates.

1. Stringer Plates.

(*a*) Stringer plates are to be fitted at the ends of all deck beams. They are to maintain their full midship scantling for 1-2 length amidships. At the ends they are to taper as specified; except in vessels on the Great Lakes with machinery fitted aft, where no reduction from midship scantling will be allowed abaft the 1-2 length amidships.

(*b*) The stringers on the lower deck beams can be 2-3 the width, but of the same thickness as those on the upper deck beams.

(*c*) The stringer plates on a hurricane deck; midship bridge house; poop; and topgallant forecastle are to be 2-3 the width of the main deck stringer at corresponding frames. The thickness may be 1-16 inch less than for a main deck stringer, when said main deck stringer thickness is 3-8 inch and under; but 2-16 less when said main deck stringer is over 3-8 inch thick.

(*d*) The stringer plates on a raised quarter or a raised fore deck are to equal those on the main deck in all respects. The main deck stringer in these classes of vessels should extend at least 3 frame spaces beyond the break of said raised quarter or fore deck; tapering thence from full width at said points to the width of the molded frame flange at their ends.

(*e*) The main deck stringer of all freight sailing vessels is to be 1-16 inch thicker than otherwise.

(*f*) The stringer plates on all weather decks are to be secured to the shell plating by a continuous gunwale bar; said bar on hurricane deck; full poop; enclosed bridge house or topgallant forecastle being equal to the reverse bars, but in no case heavier than 3 inches by 3 inches by 6 pounds. When a rounded gunwale is worked the gunwale bar is to be fitted at inside of said round so as to form a margin for the wood decking.

(*g*) When the tabulated thickness of the stringer plate of a barge not fitted with propelling machinery is not under 10 1-2 pounds, it may be made 2 pounds lighter than the tabulated thickness.

2. Deck Plating.

(*a*) All vessels are to have a steel deck, equal in thickness to the upper part of bulkhead plating, worked on the main deck in range of the machinery space. Said decking is to extend at least one beam space before and abaft the bulkheads at the ends of the machinery space and thence taper for two more beam spaces into the stringer plates.

(*b*) Steel decks extending the entire length of a vessel may be reduced by 1-16 inch in thickness before and abaft the 1-2 length amidships, when their midship thickness is 5-16 inch or above. Said reduction will not be allowed abaft said 1-2 length in vessels on the Great Lakes with machinery located aft.

(*c*) If a steel deck has no wood decking worked over it, it shall be 1-16 inch thicker than the upper part of the bulkhead plating. In such vessels a bulb plate strong back should be scored over the beams on the under side of the deck plating at the middle line; having double clips to the deck plating equal to reverse bars. It shall extend below deck beams sufficient to allow a satisfactory connection of the stanchions to said bulb plate.

(*d*) Butts of all deck plating shall have a two-frame space shift.

3. Tie Plates.

(*a*) Vessels of 50 tons and above, or those which are over 16-foot beam, not having steel decks, must have tie plates extending all fore-and-aft on each side of the main deck hatches or other deck openings. Also on the lower deck of a two-deck vessel. Tie plates on the main deck of freight sailing vessels are to be 1-16 inch thicker than otherwise.

(*b*) In sailing vessels of 15 tons or above, besides the above tie plates, diagonal tie plates are to run from the mast partners to the stringer plates both fore-and-aft.

(*c*) Tie plates are to be fitted on all hurricane, bridge, full poop, and topgallant forecastle decks.

(*d*) Tie plates are to be worked athwartships at the ends of all hatches, deck houses, etc., so as to take the ends of a wood decking when no steel deck is worked.

(*e*) Plates, equal to the thickness of the main deck stringer at their ends, are to be worked on the top of the deck beams under all deck winches; windlasses; steering gears; rudder stuffing boxes; bowsprit heels; butts, etc.

4. Mast Partners.

They should equal the thickness of the main deck stringer amidships. They shall extend for two beam spaces fore-and-aft when the beams are on alternate frames, but four spaces when the beams are on every frame. In width they are to be not less than twice the diameter of the hole for the mast, with a coaming ring equal in scantling to the keelson bars.

17. Stanchions.

1. Stanchions should be fitted to every deck beam for 1-2 the vessel's length amidships, but on alternate beams fore-and-aft of said 1-2 length. They should be worked at the center line whenever practicable, unless two rows of stanchions are adopted. In way of the shaft tunnel or for other causes, they may be fitted off the center, but not more than 24 inches; or a double row of stanchions with a sectional area of at least 2-3 of that required for a

single row may be worked. Under winches, cranes, windlasses, and other heavy weights, stanchions should be fitted to every beam. All beams at the ends of hatches are to have stanchions fitted under them.

2. When the beams are fitted on every frame, stanchions may be located under alternate beams for 1-2 length amidships, but on every fourth beam fore-and-aft of same.

3. One-deck vessels, or hurricane-deck vessels whose depth from the top of floors to the top of the main or second deck beam is 12 and under 15 feet, are to have their hold stanchions 1-4 inch larger in diameter than otherwise. When said depth is 15 feet and over the diameter is to be 1-2 inch larger than otherwise.

18. Bulkheads.

TABLE 6.—LOCATION OF FORWARD COLLISION BULKHEAD.

Vessel s Length in Feet.	Under 150	150 under 300	300 and above
Aft of stem in portion of vessel's length.......	.1 L	.085 L	.075 L

Said bulkhead is to extend to the main deck.

1. A watertight bulkhead should be fitted at each end of the machinery space; said bulkhead extending to the main deck.

2. All watertight bulkheads are to have double frame angles and be secured to an inner bottom plating with double angle bars.

3. The stern tube of steamers of less than 500 tons should be encased in a watertight compartment. In vessels of 500 tons and above, a watertight bulkhead should be worked at the forward end of said tube, extending to the main deck, with a watertight flat worked on the main deck beams over said tube.

4. All bulkheads are to have stiffeners equal to the main frames; worked vertically on one side not over 27 inches apart, and horizontally on the other not over 48 inches apart, or from floors or from deck beams. The edges of the bulkhead plates may be flanged in lieu of using stiffening angles.

5. The forward collision bulkhead plating is to be 5 pounds heavier throughout than required for the lower half of other watertight bulkheads. In all passenger and freight vessels of 500 tons and above, and in all vessels of 15-foot molded depth or 30-foot molded breadth, extra stiffening, consisting of bulb or web plates, is to be secured to the center vertical stiffener of said bulkhead.

6. (*a*) Coal-bunker bulkhead plating is to equal that of the upper half of the regular watertight bulkheads, but it need not exceed 8 pounds. The athwartship bulkheads are to have vertical stiffeners equal to the reverse bars, spaced not over 27 inches apart. Wing bulkheads are to have stiffeners equal to the main frames spaced not over 1 1-2 frame spaces apart, or they may be of reverse bar size if spaced at every frame.

(*b*) When a wing bulkhead, measured on the line of the bulkhead from the shell or inner bottom plating to the top of the deck beams, is or exceeds 9 feet in depth, tie bars worked at half-depth are to connect every third frame to the bulkhead stiffener in way of said frame.

19. Shaft Tunnels.

1. Merchant vessels with machinery placed amidships, and steam yachts of 500 tons and over, should be fitted with a shaft tunnel. When the tonnage is under 500 the plating need not exceed 8 pounds, but when the tonnage is 500 and above, the plating should be at least of 10 pounds. Stiffening bars, equal to main frames, should be spaced not more than 4 feet apart, and they should extend inside all around the sides and top of the tunnel. The part of said tunnel which comes under a hatch should have a wooden covering equal to main deck planking; with angle bars all around the edges of said cover so as to prevent chafing.

2. A watertight door is to be fitted at the engine room end of the tunnel; said door to work from the upper deck. A watertight stiffening box should be fitted to the shaft where it passes through the bulkhead at the engine room end of the tunnel.

20. Centerboard Trunks.

1. The centerboard trunk, or an attached trunk containing the manipulating gear, should extend to the main deck.

2. The lower plating should be of the same weight as the midship floor plates; being secured to a flat plate keel with continuous angle bars equal to the main frames or by a double riveted flange. The floors are to have a double clip connection to said plating; the clips being joggled over the keel bars when a flat plate keel is adopted. The upper plating is to equal that of the lower part of the regular watertight bulkheads, with its lap to the lower plating above the top of floors. Stiffeners, equal to reverse bars, are to be worked at every frame, extending from the top of floors to the main deck beams.

3. There is to be a stringer plate, in width 2-3 the center depth of floors, but equal to them in weight, on top of floors on each side of the centerboard case, secured to the trunk plates with an angle bar equal to the main frames. Said stringer plates are to extend at least one frame space beyond each end of the centerboard case and be joined to the middle line keelson.

4. The trunk plating is to be secured to a tie plate on top of the main deck beams with angle bars equal to the reverse bars. The plating is to be scored out so that said deck beams can be worked continuously, with watertight staple work at same.

(*Note.*—When a centerboard trunk is worked flush with the top of floors, as in deep-draft yachts, the reverse bars should be secured to the fore-and-aft angle bar on each side of the top of said trunk, or else reverse clips should be worked across the top of said trunk connecting the ends of the interrupted reverse bars: or other means be provided for maintaining the continuity of strength.)

21. Shell Plating.

1. The shell plating should maintain its midship scantling for 1-2 length amidships. All shell plates should be at least six frame spaces in length except at the extreme ends of a ship. Butts of adjoining strakes are to have at least a two frame-space shift; those of alternate strakes a one frame-space shift. Butts of the garboard strakes, when a bar keel is adopted, are to have a two frame-space shift from each other, and are to be kept well clear of the keel scarphs. When a flat plate keel is adopted, the garboard butts can be in the same frame space, but they must be at least two frame spaces from the keel-plate butts. Sheer and gunwale strakes are to have a two frame-space shift from the butts of their respective deck stringers.

TABLE 7.—REDUCTIONS IN WEIGHT OF SHELL PLATING. LBS.

Part of Shell Plating.	Shell Plating Including Sheer Strake.					Garboards.	
Type of Vessel.	Steamers.			Sailing.		Side Wheelers. Twin Screw.	Single Screw.
Tabulated Weight Amidships. Lbs.	10 under 16	16 under 22½	22½ and above.	12 under 17	17 and above.	14 and above.	16 and above.
For ¼ length fore and aft the ½ length amidships	2	..	Gradually reduced fore and aft of ½ length amidships to 6 lbs. less at extreme ends.	2	..	2	a 2
" ⅛ " " " " " " " "	..	2		..	1½	..	..
" ⅛ " at ends	..	4		..	3	..	..

Reductions to be figured from weight of midship plating.
a. Forward of the ½ length amidships only. Aft plating to maintain full midship weight to stern post.
No reduction will be allowed abaft the ½ length amidships in vessels with machinery located aft.

2. Sailing Vessels.

(*a*) When the tonnage is 200 but under 800, one bilge strake is to be 2 pounds heavier than the tabulated weight. When the tonnage is 800 and above, two bilge strakes are to be 4 pounds heavier than the tabulated weight.

(*b*) When under 50 tons, sailing yachts should have one strake at bilge 2 pounds heavier than otherwise. When of 50 tons and above, to have the main sheer strake and one bilge strake 2 pounds heavier than otherwise.

3. Single-screw vessels are to have those plates which are attached to the stern post of the same weight as the midship plates of the corresponding strakes.

4. The bulwark plating is to be of at least 6 pounds in vessels of less than 500 tons and fitted with close bulwarks; said plating to be not less than 8 pounds when the tonnage is 500 and above.

5. The side plating of full poops; topgallant forecastles; midship bridge houses; and of hurricane-deck vessels above the main deck, can be reduced by 2 pounds fore-and-aft of the 1-2 length amidships, when the midship weight is 8 pounds or above. The sheer strake of said decks is to be of the same weight as the side plating, but it is to maintain its full midship weight throughout.

6. The sheer strake of a raised quarter or fore deck located within the 1-2 length amidships is to be of the same weight as the side plating of a full poop, etc., vessel as above (No. 5), but with a reduction at ends as specified in Table 7 as for general shell plating.

7. Tug-boats are to have their main sheer strake and one bilge strake 2 pounds heavier than otherwise when under 100 tons. When of 100 tons and above, the main sheer strake is to be 3 pounds heavier, and one bilge strake 2 pounds heavier than otherwise.

8. In vessels trading upon the Great Lakes that part of the vessel's shell plating, except the flat keel plates, which would ground in shoal water, is to be 25 percent heavier than otherwise; but in no case need it exceed 30 pounds.

9. Shell liners at bulkheads are to extend from the fore edge of the frame before to the aft edge of the frame abaft the bulkhead.

10. When cargo ports are cut in the shell plating under the main sheer strake, and are two or more frame spaces in length, the shell strake above and below said door opening is to be doubled for at least two frame spaces fore-and-aft of said opening. Unless absolutely necessary the main deck sheer strake should not be cut for a port door; but when it is cut, it must be reinforced so as to maintain the continuity of strength.

11. In a vessel with a raised quarter or fore deck and not over 500 tons, the main sheer strake at the point of the break is to be 2 pounds heavier than otherwise, with treble-riveted butts, for not less than 5 frame spaces fore-and-aft of said point, if the length of either of said decks exceeds 1-4 the vessel's length for tonnage. When the tonnage is over 500 and said length exceeds 1-4 the vessel's length the main sheer strake is to be worked double for the same distance.

22. Butt Straps.

1. The fiber of all double- and treble-riveted butt straps must run in the same direction as that of the plates they connect.

2. All butt straps must entirely cover the seams of the plating over which they are fitted.

3. Double butt straps are to be fitted to all continuous plate keels and keelsons; to all continuous plate middle-line keelsons; to all middle-line keelsons on top of floors; to all side longitudinal plate girders of double-bottom vessels; and to all floor plates.

4. The thicker of two plates is to regulate the thickness of the butt strap that connects them.

5. Double butt straps must not be less than 3-4 of the thickness of the plates they connect.

6. Single-riveted butt straps must at least equal the thickness of the plates they connect and be in width at least 7 times the diameter of the rivets used.

7. (*a*) Double-riveted butt straps must not be less in thickness than the plates they connect.

(*b*) In vessels of 500 but under 1,000 tons, all double-riveted butt straps of the shell plating below the main deck are to be 2 1-2 pounds heavier than the plates they connect for 1-2 length amidships. But when the tonnage is 1,000 and above, they are to be 2 1-2 pounds heavier all fore-and-aft.

8. Treble-riveted butt straps must be at least 2 1-2 pounds heavier than the plates they connect. When fitted to shell plates 54 inches or more in width, they must be 4 pounds heavier than stated in Table 8.

9. Single butt straps fitted to a steel deck are to be 2 1-2 pounds heavier than the plates they connect. In bulk freight vessels upon the Great Lakes with machinery fitted aft, said straps are to be 5 pounds heavier than the plates they connect if worked single; but not less than 3-5 of the thickness of the plates they connect if worked double.

10. (*a*) Butt straps of the inner-bottom plating are to be 2 pounds heavier than said plating when worked single.

(*b*) In bulk freight vessels upon the Great Lakes with machinery fitted aft, the butt straps of the inner-bottom plating are to be 4 pounds heavier than plates they secure when worked single; but not less than 3-4 the thickness of said inner-bottom plating when worked double.

11. All angle-bosom clips at the reverse-bar butts are to be of same scantling as the reverse bars.

12. Width of single-riveted edge strips are to be not under 7 or over 8 diameters of the rivets used. Width when double-riveted is to be not less than 11 1-2 or more than 12 1-2 diameters of the rivets used.

13. Edge strips are not to be of less weight than the plates they connect.

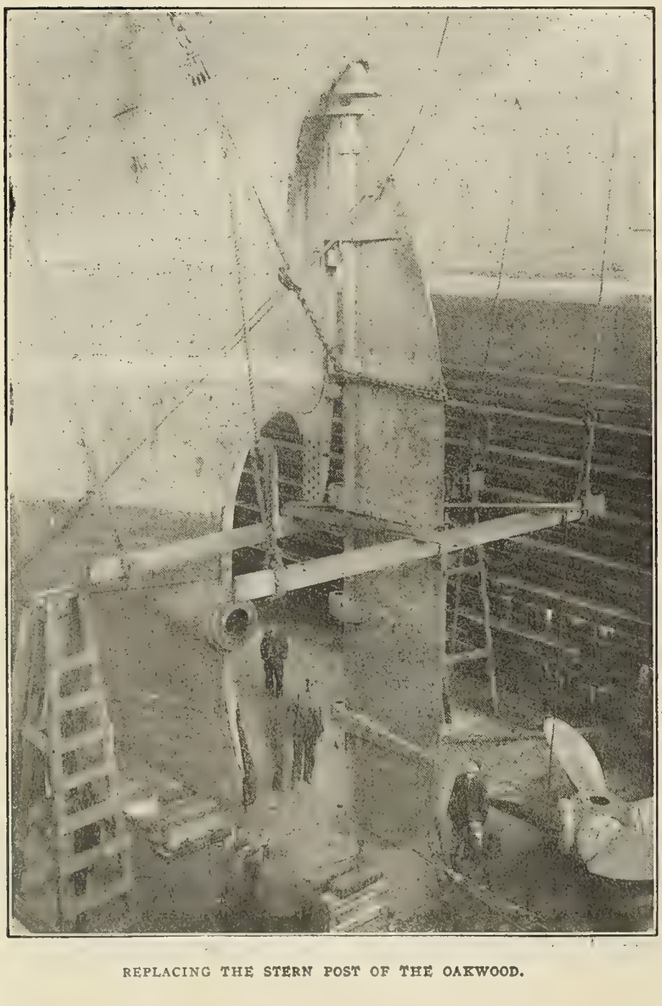
TABLE 8.—WEIGHT OF DOUBLE AND TREBLE RIVETED BUTT STRAPS.

Weight of Plate. Lbs.	4	6	8	10	12	14	16	18	20	22	24	26	28	30	34	36
Weight of double riveted butt straps. Lbs.	5	7	9	11½	13½	15½	18	20	22	24	26	28	30	33	37	39
" " treble " " " "	6	8	10	13	15	18	20	22	24	26	29	31	33	36	40	42

Repairs to the Steamship Oakwood.

Having run aground in Delagoa Bay the steamship *Oakwood* was repaired in New York by the fitting of a forged iron stern frame. She later again grounded on a voyage from London to Buenos Ayres, off Point Indio, near the river Plate, and having discharged cargo at her destination she returned to Hull, England, where she was placed in dry-dock and thoroughly overhauled, the forged iron stern post being replaced by a steel one. The extent of the repairs is shown in the accompanying photograph.

The *Oakwood* measures 2,792 tons net, and 4,271 gross, has a length of 360 feet, a beam of 48 and depth of 28 feet. The triple-expansion engine has cylinders 25, 41, and 69 inches in diameter, with a 48-inch stroke. She was built in 1903.

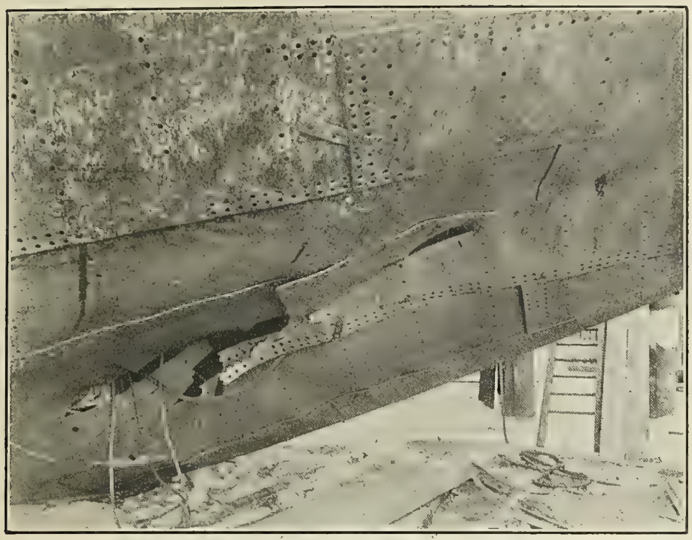


REPLACING THE STERN POST OF THE OAKWOOD.

The Damage to the City of Everett.

In collision with the Norwegian steamship *Leif Erickson*, off the coast of Florida, the steamer *City of Everett*, belonging to the Atlantic Refining Company, of New York, sustained damages to the bottom which are shown in the accompanying photograph. Strange to relate the bow of the ship did not appear to have been damaged, all of the trouble appearing to have come far back from the fore foot and under the bottom, where the plating was broken and bent, as shown. The *City of Everett* is of the whaleback type, and was launched in 1895 by the Pacific Steel Barge Company of Everett, Wash. It is said that she is the largest steel merchant vessel ever constructed on the Pacific coast. She measures 348 feet length between perpendiculars, 361 feet over all, 42 feet beam, 25 feet 6 inches deep, and carries 4,200 tons of cargo and 375 tons of coal. Her tonnage is 2,504 gross and 1,858 net. She is divided by six watertight bulkheads, and is propelled by a triple-expansion engine with cylinders 24, 38, and 64 inches in diameter, with a 42-inch stroke. She has four Scotch boilers measuring 11 feet in diameter and 11 feet long, and designed for a working pressure of 165 pounds. Repairs were made at the Erie Basin.

The *Leif Erickson* was built at Bergen, Norway, in 1889, measured 288 feet in length, 38 feet wide, and 20 feet in depth,



THE DAMAGE TO THE BOTTOM OF THE EVERETT.

(Photo by Geo. P. Hall & Son.)

with a gross tonnage of 2,128 and net 1,340. She was propelled by a triple-expansion engine with cylinders 21, 35, and 58 inches in diameter by 36-inch stroke.

ENGINEERING SPECIALTIES.

A New Surface Condenser.

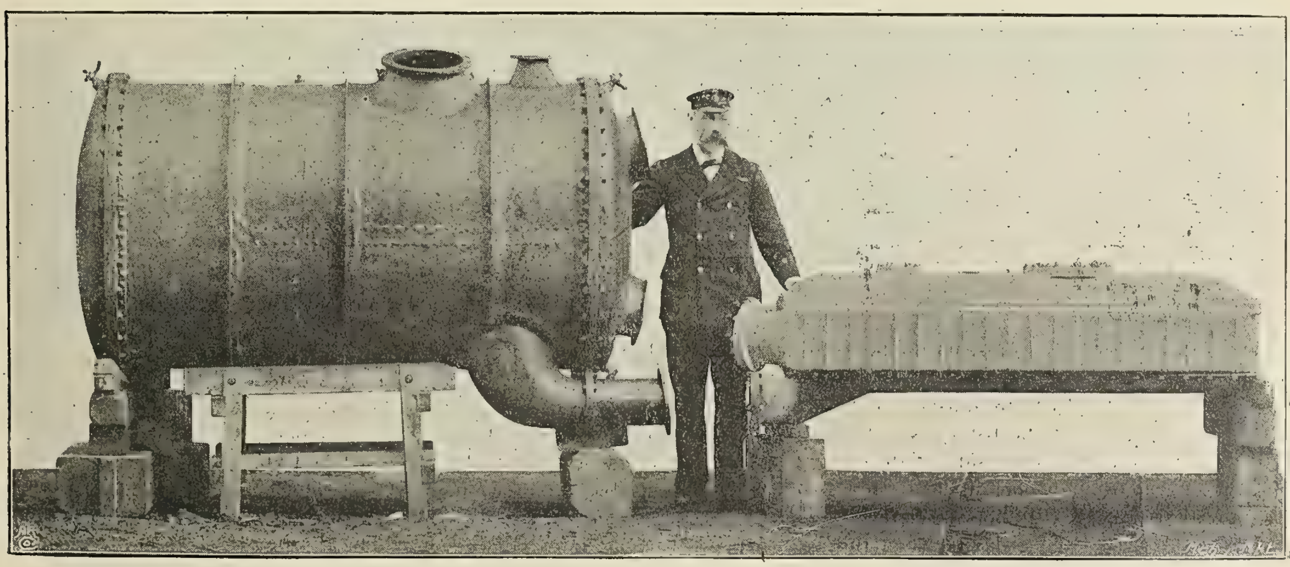
The Ljungstorm patent surface condenser, which is illustrated in the accompanying photograph, differs from the ordinary condensers of this type in that the cooling surface consists in a series of corrugated plates of sheet brass fixed together in packets so arranged that the corrugations give mutual support to each other. These plates are placed in a rectangular casing in such a manner that the cooling water flows horizontally through alternate chambers, and the steam to be condensed flows vertically through the intermediate chambers. By this means a large number of fine streams of steam and water are made to follow a sinuous course in close proximity to each other. The steam enters at the top of the rectangular casing, and is sucked out at the bottom by the air pump. The illustration gives an idea of the relative sizes of this new condenser and a condenser of the ordinary type, both designed for the same work on a torpedo-boat destroyer.

This condenser is placed upon the market by John Brown & Company, the American representative being Mr. W. Bloor, 22 Thames street, New York.

The Babcock Fire Extinguisher.

This is the invention of Professor James Babcock, of Boston, and dates from about 1870. It is only recently, however, that it has been arranged for use on shipboard. The principle on which it operates is the mingling of bicarbonate of soda with sulphuric acid to generate a sufficient pressure to throw a stream of the

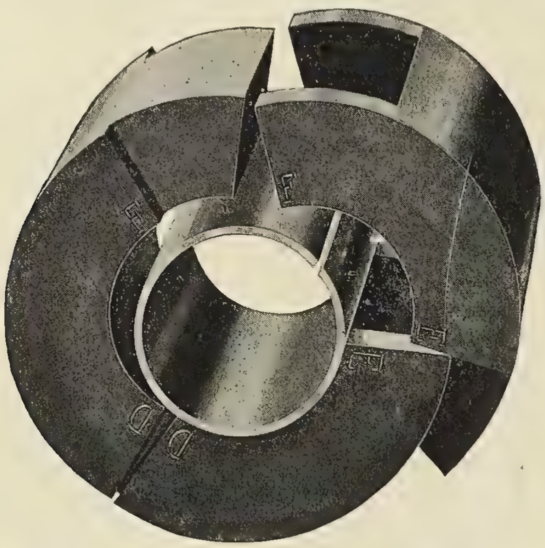
chemical for fire-extinguishing purposes, and it is the carbonic gas generated which operates as an extinguisher. The Babcock, as constructed by the American-La France Fire Engine Company, of Elmira, N. Y., is made of one solid sheet of heavy copper, without rivets or joints, and leaded on the inside to prevent corrosion.



In operation the acid bottle is broken and the entire contents thrown into the soda at once, as compared with which other extinguishers allow the acid to be thrown gradually into the soda, and thus do not attain their highest efficiency at the start, when it is most needed. The stream is controlled by a shut-off valve which prevents waste.

The Stayman Piston Valve.

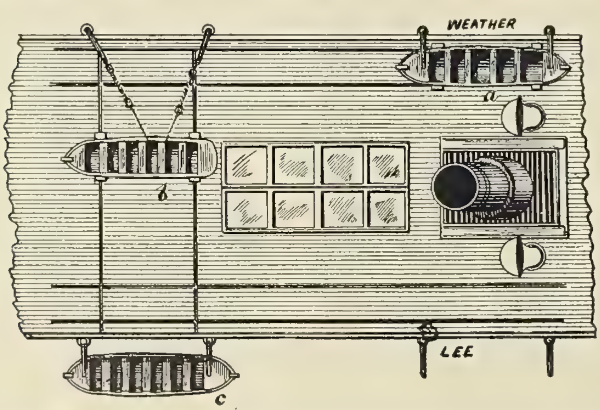
The main feature of this valve, which differentiates it from those of the regular type, consists in the method of holding the piston against the casing. Instead of having a solid head with small piston rings pressed out by either their own elasticity or that of springs, this valve has a head which consists of three parts so



arranged as to prevent the leakage of steam past them, and held to their work by means of a central spring, as shown in the photograph. Tests of these valves appear to show a considerable increase in efficiency over the older type, while the design is especially well adapted to avoid unequal conditions of wear. The valve is marketed by the Stayman Manufacturing Company, 143 Liberty street, New York.

A New Boat-Launching Gear.

In cases where a ship of modern construction becomes disabled it is obvious that all the boats should be at once available. A ship in such a predicament usually lists over dangerously, and



inasmuch as the weather side presents the larger area to the wind and to the sea, she naturally swings so as to present this side flat to the weather. Under such circumstances the ship becomes, as it were, a breakwater, and the list causes the lee davit tackle to swing outwards, away from the side of the ship. To launch the weather boats from their proper davits would be to ensure their destruction; if they can easily be moved to leeward, so that they may be lowered from the lee davits when the tackle is clear of the lee boats, a great increase has been attained in the life-saving power of the ship's appliances.

The chocks are of the ordinary type now used, but instead of resting flat upon the boat deck they are supported by ball rollers, which run in a slightly grooved rail let into the deck. Normally wedges hold the boats firmly in position against motion of the ship. The grooved rails run transversely and also longitudinally, and cross-junctions are provided. By the figure we may describe the procedure: The boat *c* is ready for launching on the lee side; *b* is being run over the thwartship grooved track ready to occupy the davits and tackle now holding *c*, and the weather tackles are attached to *b* to "brake" its run down the decline of a possible "listing" deck. The boat *a* may be run along the fore-and-aft track clear of the funnel, ventilators, and skylight, and then thwartships to the nearest lee davits that happen to be free. The device is a recent invention of Captain V. H. Spalding, of London.

TECHNICAL PUBLICATIONS.

The Mechanical Handling of Material. By George F. Zimmer, A. M. Inst. C. E. 521 pp. 7½ by 10¼. 542 illustrations. New York: D. Van Nostrand & Company, 1905. Price $10 net.

This very important book had its original basis in the author's practice in the general line of handling material, and in the designing of appliances for its mechanical handling and transportation. It has not, however, been by any means confined to the practice of any one man, or any one country, but deals with work comprised within the general heading all over the world, and gives examples from the practice of perhaps hundreds of engineers of the last two or three decades. Being very copiously illustrated, it is of especial value to engineers interested in the subject, and ought to form an excellent reference book. The work is divided into four sections, of which the first is devoted to the continuous handling of material, and gives details of various sorts of elevators, worm and band conveyors, and conveyors designed for special purposes, such as those used in connection with casting machines. The second section deals with the intermittent handling of material by means of ropeways and aerial cableways, including appliances for coaling at sea. The third section is devoted to handling and loading appliances, such as skips, grabs, and various means of utilizing the machinery usually found in connection with elevators. This section also describes the discharging of railway trucks, both by the method of picking up the truck and overturning it, and by the method of dumping the contents of a truck specially designed for that purpose upon either one or both sides of the track, or in the middle. The fourth section is devoted to miscellaneous devices for the handling of material, and includes information about its automatic weighing, the coaling of railway engines, and the general subject of coal stores and coal silos.

Some little attention is paid to the very remarkable systems employed upon the Great Lakes of the United States for the loading and discharging of cargoes on the specially designed vessels used in these great inland fresh-water seas, and at the same time information is given regarding the contemporaneous practice of European engineers both in England and on the Continent. The book is gotten up in splendid style and ought to be very valuable to all engineers concerned with any phase of the subject.

The Shipping World Year Book. Edited by Evan Rowland Jones. 1,316 pp. 4½ by 7¼ inches. New York: The Derry-Collard Company, 1905. Price $3.

After an introduction involving a retrospective view of the year 1904, this book goes on with a mass of tables of interest to shipbuilders and shipping men generally, such as a list of ports in the world, with ships entered and cleared; statistics of imports and exports; astronomical and tidal information; tables of freeboard; particulars of Suez Canal traffic; general statistics of ships of various nations, etc. There follows a digest of the shipping acts of the various countries, and after this come two very important sections, which occupy more than a thousand pages in the book. The first of these is a port directory of the world, giving all ports used by steamers and sailing vessels, with very complete particulars regarding the population, the size, and depth of the harbor, the condition of the channel, and all sorts of information of a like character. The other section deals with the tariff laws of the various countries, giving schedules in sufficient detail to be of immense value to shipping men generally. In a pocket in the rear of the book is a map of the world, on Mercator's projection, printed in four colors, and giving marginal maps of a number of the most important ports, such as New York, Liverpool, Cork and Queenstown, Southampton and Portsmouth, San Francisco, Rio Janeiro, London, Yokohama, and a number of others. We have no doubt that the work will find a ready acceptance at the hands of those engaged in forwarding merchandise or operating ships.

Gas Engines and Launches: Their Principles, Types, and Management. By Francis K. Grain, M.E. 123 pp. 4½ by 6¾ inches. 21 illustrations. New York: Forest and Stream Publishing Company, 1905. Price $1.25.

This little book, which ought to be of special interest and value to owners and operators of gasoline launches, covers quite thoroughly the general subject of the gasoline engine of both the two-cycle and the four-cycle type, and gives a large amount of information on what might be called the subsidiary devices of the engine, such as igniters, vaporizers, etc., as well as wiring schedules for batteries. The subject of propellers and hulls is given merely incidental notice at the rear of the book, where some general remarks are made regarding the proportioning and design of both of these features of the boat. The last part of the book is devoted to discussions of the methods of management of the engine and boat, and a series of cautions as to what to do or not to do under various contingencies.

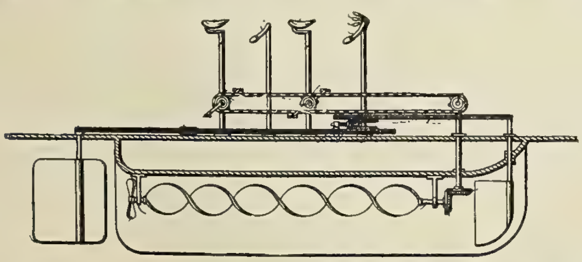
The Nautical Technical Dictionary for the Navy, in English, French, German, and Italian. Vol. II., Part 1, A to K. 1,355 pp. Pola: published by Mitteilungen aus dem Gebiete des Seewesens, 1905. Price 30 marks.

This monumental work is the result of many years of labor on the part of Julius Heinz, a retired rear-admiral of the German navy, the first volume having appeared in 1900, and the second at this time. The dictionary is arranged in two ways, the first being with all English and French words in sequence, and the second being systematical according to the similarity of technical meaning and application. The object of the latter arrangement is to facilitate research and the finding of special words. For the purpose for which it was designed, the work will prove exceedingly valuable, and should find ready acceptance by all who might have occasion to refer to anything of the sort.

SELECTED MARINE PATENTS.

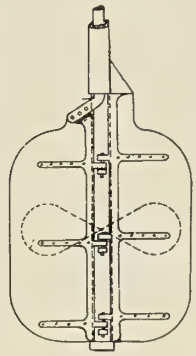
793,633. BOAT. JOHN W. BEALL, LATON, CAL.

Claim.—3. A boat having fore and aft rudders, a steering post or stem, wheels on the said stem arranged one above the other, the stem and one of the wheels having separable connecting means for throwing one of the wheels out of operative engagement with relation to the post or stem, a rod connected to the wheel which is adapted to be thrown



out of engagement with respect to the stem, said rod extending adjacent to the upper terminal of the said stem, and flexible connections between each wheel and one of the rudders whereby the latter may be simultaneously or independently operated in either direction. Three claims.

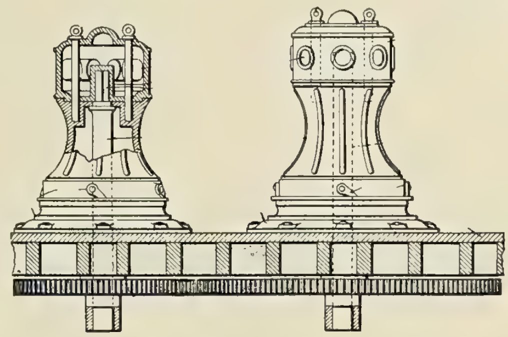
793,746. MEANS FOR CONTROLLING THE SPEED OF SCREW-PROPELLED SHIPS. EDWARD SMETHURST, CHRISTCHURCH, NEW ZEALAND.



Claim.—1. In means for controlling the speed of screw-propelled ships, a sleeve upon which is mounted a rudder and a shaft coaxially situated with and within the sleeve upon which a second rudder is mounted, and means for operating the pair of rudders either together or reversely to each other in conjunction wth the revolving propeller of a ship. Three claims.

793,909. CAPSTAN. WILLIAM J. ROBERTS AND ALBERT F. SHULTZ, KEYWEST, FLA.

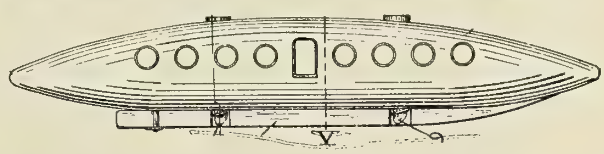
Claim.—3. In a capstan construction, spaced shafts connected for rotation by gears of different diameters, a capstan mounted for rotation



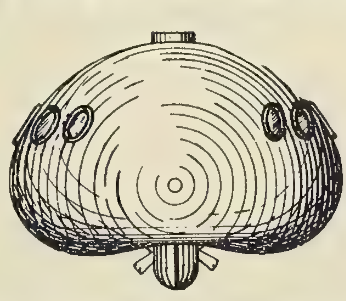
upon each of said shafts, each of said capstans having a head connected for rotation with its respective shaft, and removable pins extending through said head members into their respective capstans and forming detachable coupling means between them. Three claims.

793,944. BOAT. CAREY A. MANKER, PEARL, ILL.

Claim.—1. A boat having a concavity at the lower side of its hull terminating at its forward end above the lowermost surface of the hull to provide free entrance for water into the front end of the cavity; said concavity merging into the lowermost surface of the hull at its rear end rearward from the longitudinal center of the boat.



2. A boat having at the lower side of its hull a pair of longitudinal limbs extending from the forward end of the hull to a point beyond the longitudinal center of the hull; said limbs providing a concavity terminating at the forward end between said limbs and above



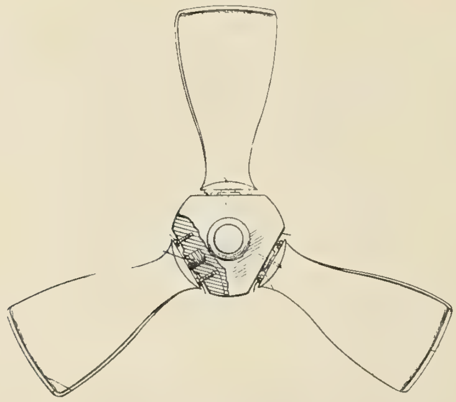
the lowermost surface of the hull and terminating at its rear end at the lowermost surface of the hull and rearward from the longitudinal center of the boat. Two claims.

794,010. PROPELLER. WILLIAM B. HAYDEN, NEW YORK, N. Y.

Abstract.—This invention relates to screw-propellers; and the object thereof is to so construct the propeller as to enable the adjusting of the propeller-blades to a less or greater degree of pitch, whereby the position of the blades may be adapted to the particular degree of speed or power desired in the vessel propelled.

The invention further aims to provide a screw-propeller with a plurality of adjustable abutments adapted to engage the base of the blades to prevent the turning or loosening of the blades when in their set positions.

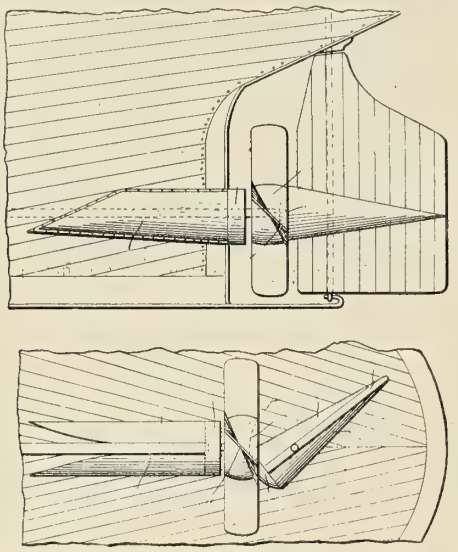
The invention further aims to provide a screw-propeller with means



to readily ascertain whether the proper degree of pitch has been obtained when positioning the blades. Twelve claims.

794,317. PROPELLER FOR VESSELS. JOHN SAUNDERS, JR., GREENBAY, WIS.

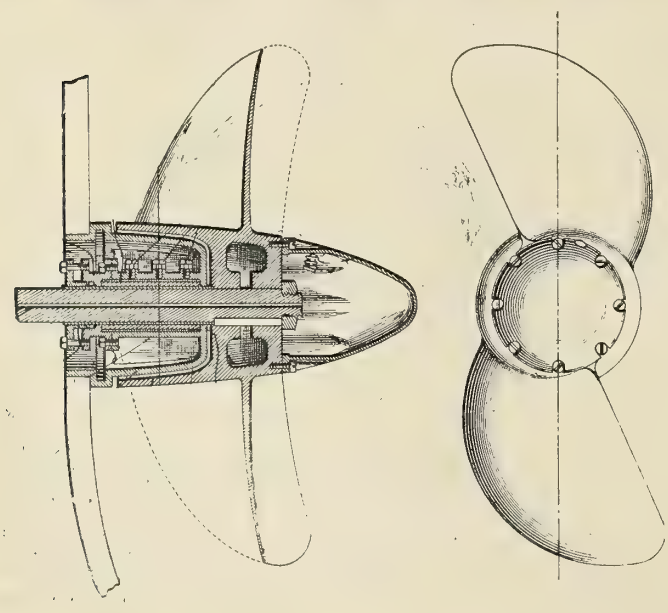
Claim.—A vessel having a propeller having an enlarged hub, said vessel having a water-shed disposed in front of the propeller-hub and corresponding in diameter at its rear end to the diameter of the hub, the latter



having a concave recess in its rear side, and a rudder having a cap provided with a crown of segmental form projecting from the front side of the rudder and extending into the recess in the propeller-hub. One claim.

794,932. PROPELLER. JOHN D. FULLERTON, BOSTON, MASS.

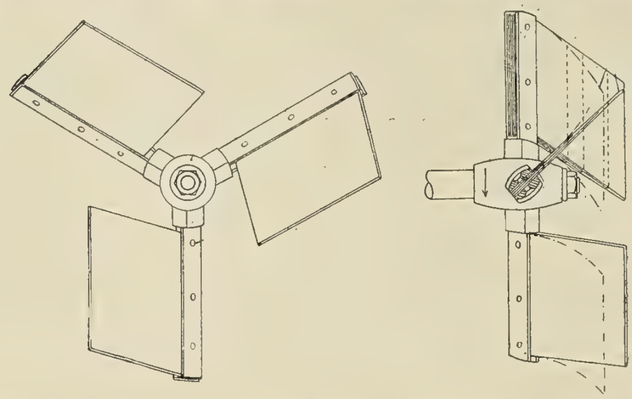
Claim.—1. In a propeller, a propeller-shaft, a bearing therefor, a screw-propeller on the bearing, said propeller having a hub formed with an extension which overlies and surrounds the bearing, and also having thin blades extending forwardly to the front edge of the hub extension, and



having an entrance edge which slants backwardly in the direction of the length of the shaft. Four claims.

794,984. PROPELLER. JOSE HUBER, SANTIAGO, CHILE.

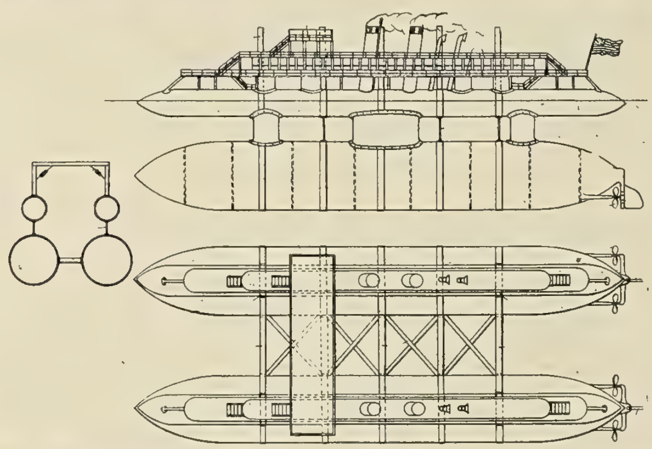
Claim.—9. In a propeller, the combination, with a shaft, and rigid supporting-arms carried thereby, of resilient laminated blades secured to the arms at substantially right angles to the shaft, said blades being



composed of a plurality of plates of unequal length arranged between two outer plates of substantially equal dimensions and having the shape of a rhomboid, substantially each portion of the operative surface of the blades lying within a circle struck from the axis of the shaft and having a radius equal to the length of the arms. Sixteen claims.

795,002. VESSEL. ALBIN NELSON, GLADSTONE, MINN.

Claim.—2. A vessel of the class described consisting of two submerged hulls, propelling mechanism therefor, a pair of smaller hulls supported

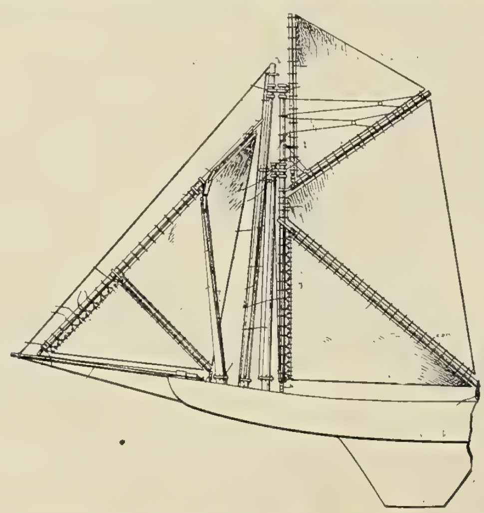


above said submerged hulls, and a bridge connecting said upper hulls. Four claims.

795,025. RIG OF SAILING VESSELS. BYRON W. COLLINS, EVANSTON, ILL.

Claim.—5. In a fore-and-aft-rig sailing vessel a two-part sail, a boom extending between the two parts of the sail and secured thereto, the jaw of the boom being arranged higher than the peak and the latter being secured to the clews of both parts of the sail.

6. In a rigging of the class described, a mast, a pivoted lever, a sail-carrying arm, a sail carried by the arm and extending upward above



the point of connection between the arm and lever, and a pair of halyards arranged one on each side of the lever and extended upward following the lines of the lever and arm and connected to the peak of the sail. Nine claims.

Marine Engineering

OCTOBER, 1905.

THE SELF-DOCKING STEEL FLOATING DRY-DOCK DEWEY.

For the purpose of providing docking facilities in the Philippine Islands, which should be capable of caring for any ship of the United States Navy either now in those waters or to reach them in the future, the United States government, under an act of Congress approved July 1, 1902, called for proposals to be received by the Bureau of Yards and Docks in the Navy Department, and opened March 14, 1903. Under these proposals that of the Maryland Steel Company, of Sparrow's Point, Maryland, having been found to be the most satisfactory in every way, was adopted, and contract accordingly entered into with them April 20, 1903, for the construction and equipment of the dock. The contract was the more readily awarded to the Maryland Steel Company because of the fact that they had previously had a very successful experience in this line of work in the construction of the large dock owned by the United States government, and now in operation at Algiers, La., opposite the city of New Orleans.

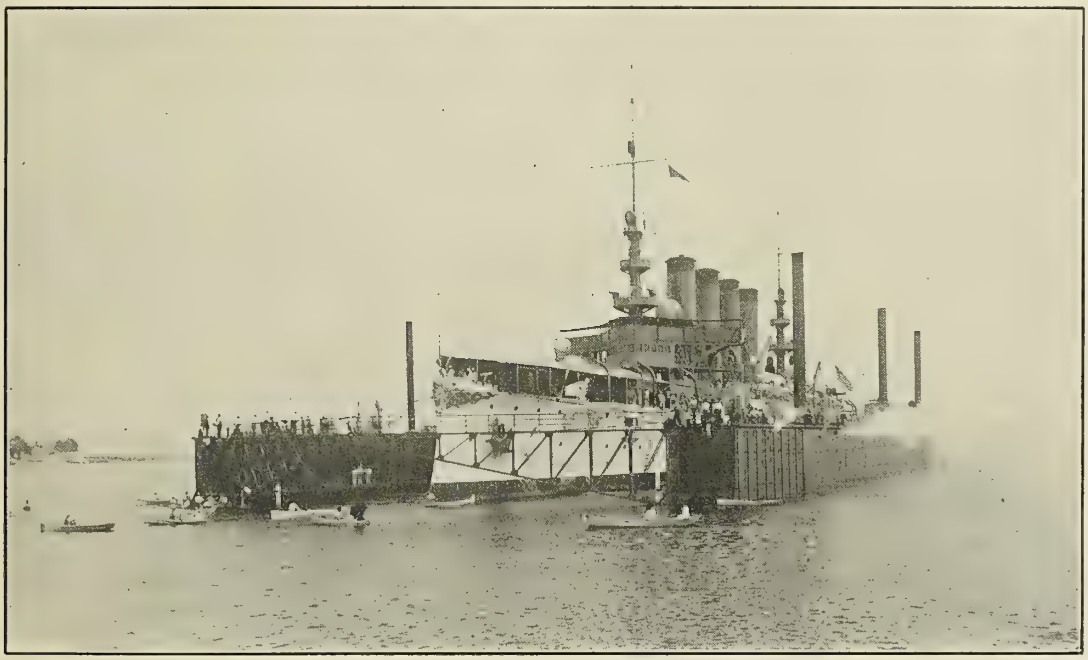
The specifications issued by the government contained the following general requirements:

"The dock in general shall be an open-hearth steel structure, so designed and arranged as to be readily self-docking without the aid of divers or of auxiliary constructions. It shall be self-contained as to operating machinery, and capable of being towed safely from place to place without auxiliary bracing. It shall be of the general type, composed of watertight side walls, and body or pontoons with a general U-shaped cross section, and divided into a sufficient number of watertight compartments to give great stability, there being not less than six transversely.

"It shall be not less than 500 feet long over all outside of bracket platforms. It shall have a clear width between fenders of not less than 100 feet. The decks of the side walls shall have not less than 8 feet of clear height above the water with 30 feet draft over 4-foot keel blocks. The dock shall have a lifting capacity of not less than 16,000 gross tons uniformly distributed over its entire length, with the main deck not less than 2 feet above the water, and with not less than 1 foot of water in the compartments. It shall be designed to take all classes of vessels of the United States Navy, either centrally or with the center line of the keel 1 foot off the center line of the dock. It shall be so designed that the entire weight of a battleship may be safely carried by the main keel blocks, or one-half the weight on each line of docking keel blocks, and the side walls shall be designed to take shoring at any point which may be necessary.

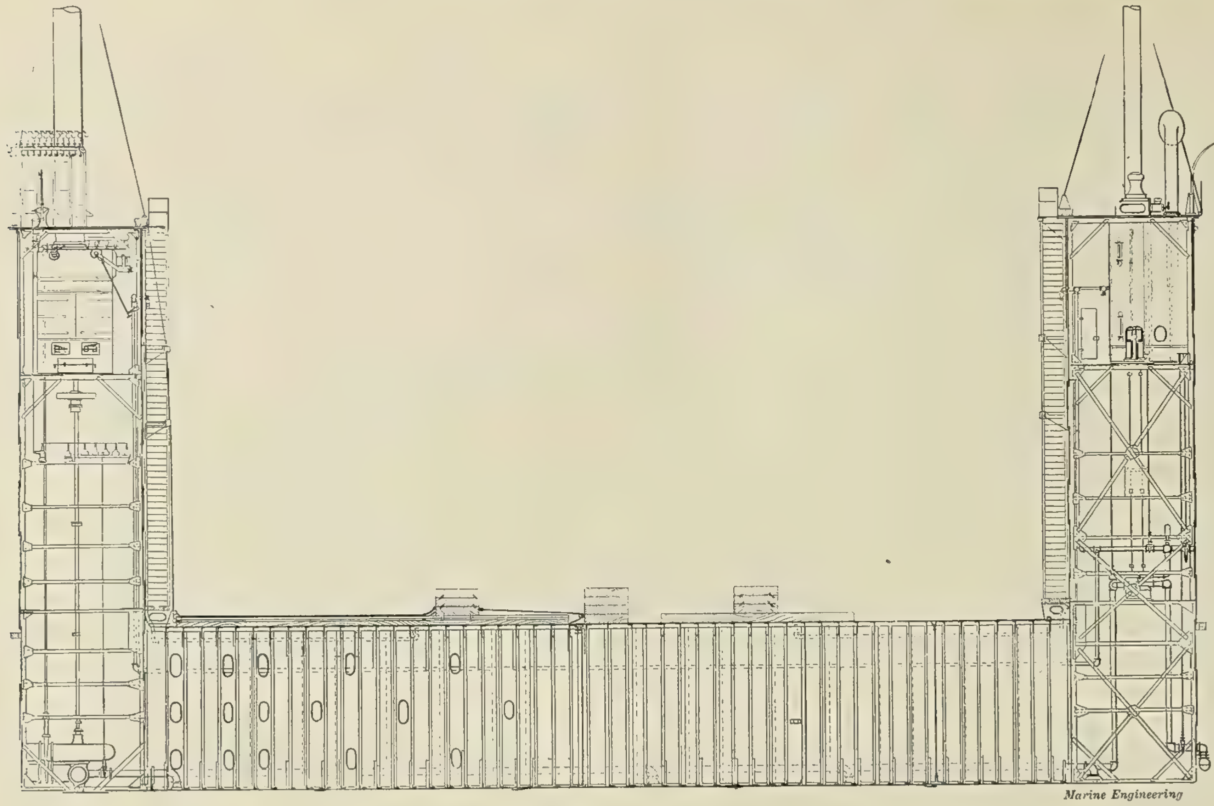
"No portion of the dock or its connections shall have a stress of more than 10,000 pounds per square inch under the specified loads, nor more than 15,000 pounds per square inch in self-docking, with a wind pressure of 30 pounds per square foot of exposed surface.

"The working deck of the dock shall be flush plated and so



FLOATING DOCK DEWEY RAISING ARMORED CRUISER COLORADO.

(Photograph by Groeninger, Baltimore.)



CROSS SECTION OF THE CENTRAL SECTION OF THE DOCK.

strengthened that docking keel blocks may be placed in any position, and the dock shall be so designed that the specified unit stress shall not be exceeded when the dock is pumped uniformly from all compartments to a freeboard of 2 feet. Under this latter condition the longitudinal and lateral deflection over the entire working deck of the dock shall not exceed 1 in 2,000. Within the limits of allowed deflection the ship-load shall be assumed to be perfectly flexible.

"The decks of the side walls shall have a clear passage fore and aft of not less than 5 feet in width, with a hand rail on the outboard side, and passage shall be provided from one side wall to the other, as well as telephone or speaking-tube communication between the two side walls, along the walls, and with the engine room.

"When self-docking, all under-water portions shall be raised to a clear height of not less than 5 feet for ready accessibility for inspection, painting, and repairs. The dock shall be operated by steam power and fitted with all the necessary boilers, engines, pumps, feed-water heaters, steam separators, and other auxiliaries desirable to make a first-class self-contained plant. This plant shall be of not less than 600 horsepower, with all boilers and engines suitably distributed to give the best results. A small

THE BATTLESHIP IOWA ENTERING THE SUBMERGED DOCK.

(Photograph by Groeninger.)

ARMORED CRUISER COLORADO ENTERING DOCK.

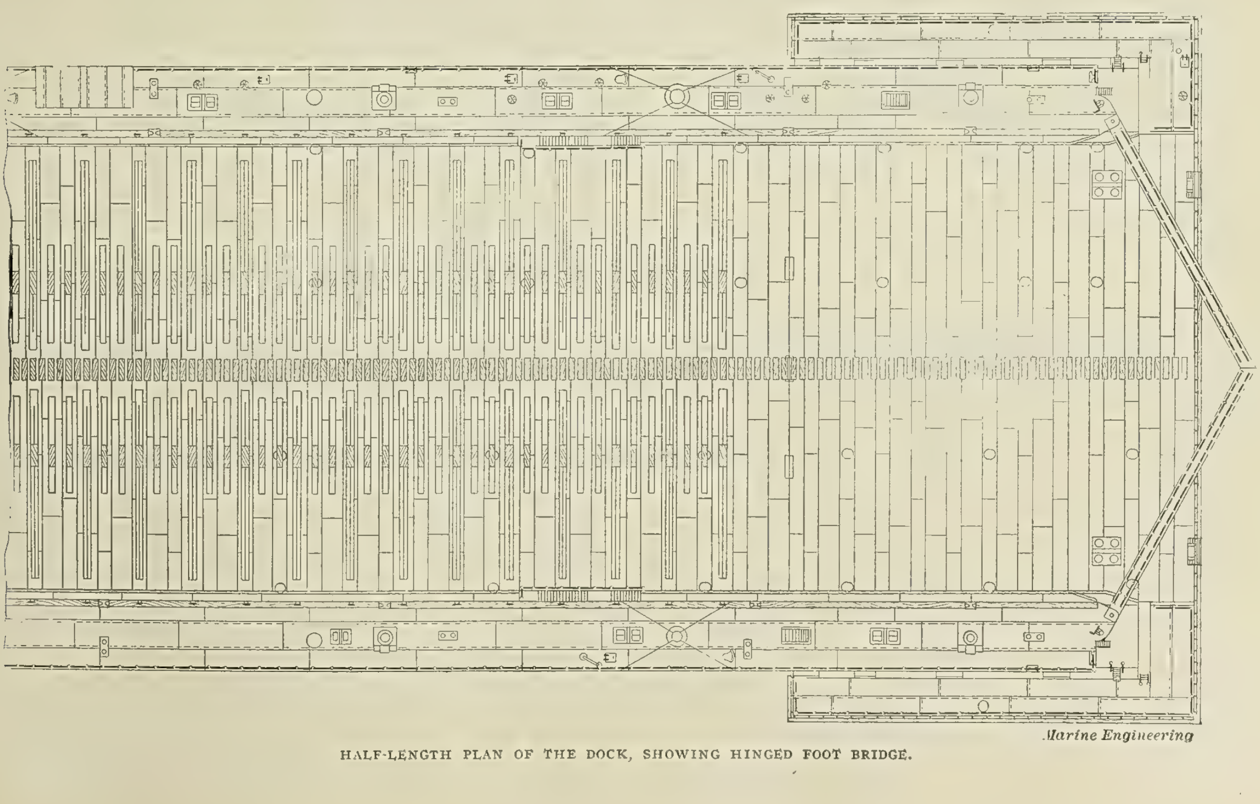
(Photograph by Groeninger.)

machine shop, suitable for light repairs to the dock, shall be installed in one side wall. Storage shall be provided for fuel and fresh water sufficient for two complete successive dockings of the maximum load. Such portions of the side walls above the engine decks as are not occupied by machinery shall be fitted as store rooms, and as quarters for officers and crew, with suitable mess arrangements. An electric-light plant shall be installed, and a blower system for ventilation of all working and storage places and quarters.

"The dock shall be designed to lift a load of 16,000 gross tons with a draft of 30 feet clear of the water in a period of four hours, the pumps being required to operate readily under a head of 35 feet."

The structural steel for the dock was required to have a maximum tensile strength of from 55,000 to 65,000 pounds per square inch, an elastic limit of not less than one-half the maximum tensile strength, and an elongation of not less than 23 percent in 8 inches. It was required to bend cold 180 degrees around a bar of diameter equal to thickness of plate, and to bend at a red heat 180 degrees flat, all without rupture on outside of bent portion. Similar requirements were made for rivet steel but with tensile strength of only 47,000 to 55,000 pounds per square inch, and for steel castings, whose strength should be upward of 60,000 pounds per square inch. The required tensile strength of wrought iron used was not less than 48,000 pounds per square inch, and all cast iron 18,000 pounds.

The design as worked out from these specifications gives a dock of a total length of 500 feet in three sections, of which the center has a length of 316 feet and the end sections each 90 feet, with a 2-foot open space between the center section and each of the others. The pontoons for the three sections are similar in transverse dimensions, the width being 134 feet over all and the

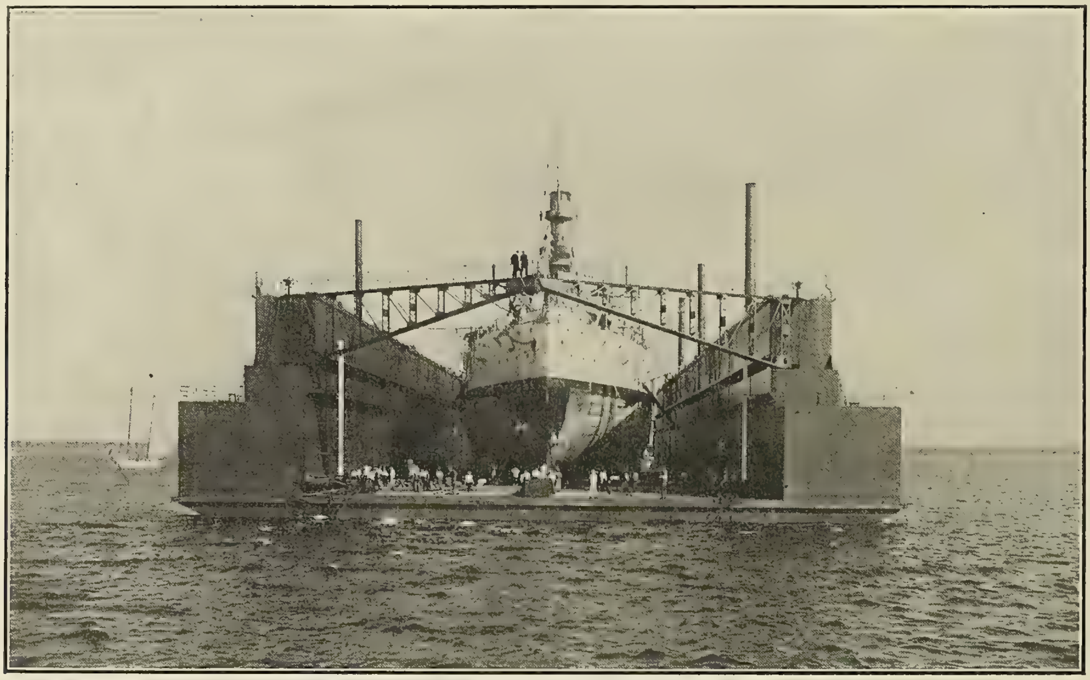


Marine Engineering

HALF-LENGTH PLAN OF THE DOCK, SHOWING HINGED FOOT BRIDGE.

depth 18 feet 6 inches throughout. This width of 134 feet is the extreme width over the side walls of the center section, whereas the end sections have a maximum width over side walls of 156 feet with free space between them 139 feet. This allows for the center section being raised by the two end sections and floated within their compass for any repairs or painting which might be found necessary, and this satisfies, so far as the center section is concerned, the requirements for self-docking. The end sections are docked by the center section by being turned through a horizontal angle of 90 degrees, and then floated in with their length of 90 feet between the side walls of the center section, which has a free space between fenders of 100 feet and a total space between walls of 106 feet. The length of the center section is seen to be sufficient to take in both end sections at once, with a clearance of 4 feet between them. The total height of the dock structure is 63 feet 8 inches, of which 45 feet 2 inches represents the height of the side walls above the main deck. The end pontoons are considerably lower than this, having a height above the dock of only 20 feet, which gives a total height for these sections of 38 feet 6 inches.

nected in the corners by the usual diagonal braces of 4½-inch by 3-inch by 7/16-inch angle bars as well as with plate gussets. In the side walls the frames are built in this same manner, but are rendered more stiff by the introduction at intervals of horizontal struts. The transverse bulkheads are 7/16 inch thick and are attached to both bottom plating and the deck by means of double angle bars and to the side walls by single angle bars. The central longitudinal bulkhead is of the same scantling as the transverse bulkhead and is fitted intercostally between them. The other longitudinal bulkheads are of the same scantling as the central and are stiffened by 7-inch by 14.75-pound channels spaced about 2 feet apart. All the plating throughout the dock is so fitted as to cross the frames at right angles. The bottom plating is, therefore, transverse between the side walls and longitudinal under them. Its thickness throughout is 24 pounds, except that under the side walls of the center pontoon, which is reduced to 22½ pounds. The middle strakes of the side-wall plating are 20 pounds thick, which is increased toward the bottom to 22½ pounds, and toward the top to 25 pounds. The upper two strakes in the center of the dock are doubled for the purpose of obtaining additional stiffness.



END VIEW OF THE DOCK, WITH BATTLESHIP IOWA ON THE BLOCKS.

(Photograph by Groeninger.)

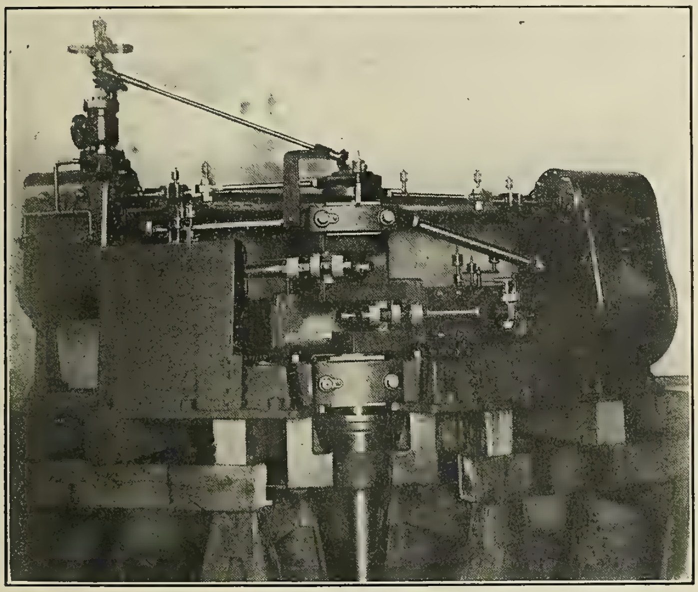
As required by the specifications, the dock is divided throughout its length into six watertight compartments by five longitudinal bulkheads, of which one is located in the center, one on each side of the center and at a distance of 22 feet from it, and one immediately under the inside wall of the side walls of the dock. By means of transverse bulkheads numbering five in the center portions and two in each of the others the entire dock is divided into seventy-two separate watertight compartments, of which thirty-six are in the central section and eighteen in each end section. In addition to the transverse watertight bulkheads are other transverse bulkheads subdividing the dock into a cellular structure and spaced 8 feet apart fore and aft. These are all fitted with large manholes and limber holes to facilitate the free passage of water within the watertight cellular subdivisons.

The frame spacing throughout the dock is 24 inches center to center, the frames consisting in 6-inch by 3½-inch by 7/16-inch angles for the vertical and bottom members of longitudinal girders, while the top members consist in each case of channel bars which measure for the central frames 15 inches by 32 pounds and for the side frames 12 inches by 25 pounds. These members are all con-

The steam plant required by the government specifications is actuated by steam generated in three Babcock and Wilcox boilers of the marine type, each boiler having a grate area of 46 square feet with a heating surface of 1,750 square feet, thus giving a ratio of the latter to the former of 38 to 1. Steam is used mainly for the purpose of pumping, and for this there are three 24-inch centrifugal pumps and two 12-inch pumps of the same type. The latter are placed in the end pontoons and are used only for self-docking, while the larger pumps are used for the regular purpose for which the dock is designed. Each of the latter is operated by a horizontal compound engine having cylinders 14½ and 25 inches in diameter respectively with a stroke of 14 inches. The cranks are at an angle of 135 degrees. Each engine, with the regular steam pressure of 140 pounds per square inch, develops at a speed of 225 revolutions per minute about 225 indicated horsepower. The engines are placed far up in the wings and operate vertical shafts leading down to the pumps, which are very near the bottom of the side walls and which discharge outboard by means of horizontal pipes. The smaller pumps are each driven by simple engines with 12-inch cylinders and 10-inch stroke direct connected to the pump shaft. The auxiliary machinery is operated by steam from a Babcock and Wilcox boiler with a grate surface of 18 square feet and heating surface of 750 square feet, and consists in the main of a 7-Kw. Sturtevant 110-volt generator driven by a simple direct-connected engine 6-inch by 6-inch, and a distilling apparatus with a daily capacity of 2,500 gallons.

The five pumps were furnished by the Morris Machine Works, of Baldwinsville, N. Y. They are placed in the bottom of the dock, with their suction openings directly on top of the main suction pipe running the full length of the dock; while the driving engines are placed on an upper deck on the side wall of the dock, and are directly connected to the pumps by a vertical shafting of 5-inch diameter. This is well shown in the illustration, which is one of the compound engines operating a 24-inch pump. The crank shaft is two-throw with the cranks opposite, and the cylinders at an angle of 135 degrees. The crank pins are 7½ inches in diameter and 7 inches long while the bearing section of the shaft has a diameter of 7 inches.

The 24-inch pumps are of the solid-shell type, and are made of cast iron of very heavy proportions, each one fitted with a bronze runner of the shrouded type 54 inches in diameter. As they are

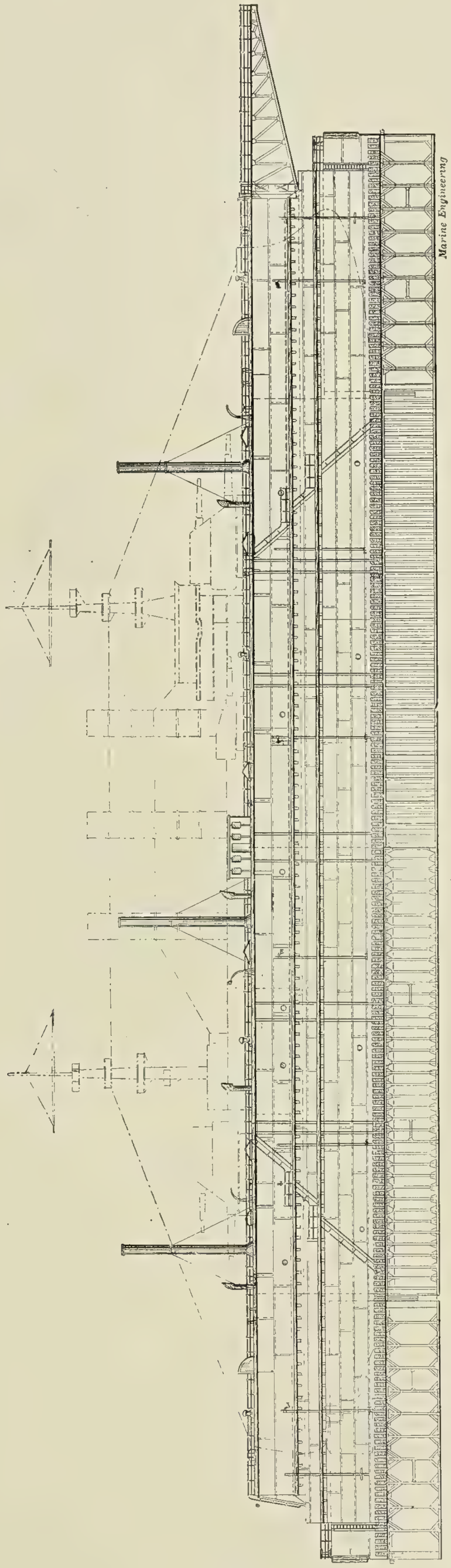


ONE OF THE PUMPING ENGINES.

worked on vertical shafts it is important that the thrust bearing be relieved in operation of as much pressure as possible. They have, therefore, been designed so that the water exerts an upward pressure on the runner or impeller. The weight of the crank shaft line shafting and impeller is carried by a ball thrust bearing hung directly under the engine framing. This is composed of two rows of 1¼-inch steel balls.

The 12-inch pumps are of the same general construction and have impellers of a diameter of 40 inches. Both types are fitted with throttling governors operated by gearing, so that in case the pumps should lose their priming the engines would be prevented from racing.

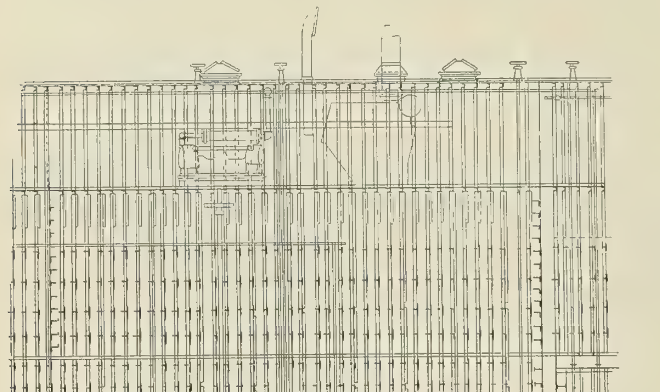
This dock is found by a comparison with existing structures to be considerably the largest of any dock yet built. The requirements, as per government specifications, call for a capacity to lift 16,000 tons with a freeboard of 2 feet. As an actual fact, it is found possible with this freeboard to lift 18,500 gross tons; and a little calculation establishes the fact that with a freeboard of 1 foot the lifting capacity of the dock is 20,400 tons, and, with the main deck awash, the lifting capacity is 22,300 tons. The comparison with other docks shows that the 18,500-ton lifting capacity with a freeboard of 2 feet is 1,000 tons greater than that of the Algiers dock built by the Maryland Steel Company, as before mentioned; and other large docks may be listed as follows:



INBOARD PROFILE OF THE DOCK, WITH A BATTLESHIP OF THE GEORGIA CLASS ON THE BLOCKS.

The Bermuda dock, built in England and now a part of the equipment of the English naval station in the Bermuda Islands, has a lifting capacity of 16,500 tons; the Austrian dock at Pola is rated at 15,000 tons; the German dock at Stettin has a capacity of 11,000; and the Pensacola dock, owned by the United States government, but which was formerly owned by Spain and was a part of the naval equipment at the port of Havana, Cuba, has a capacity of 10,000 tons.

The *Dewey,* according to the original contract, was to have cost $1,124,000, but certain modifications and additions have crept in since the work was started, and the ultimate cost will somewhat exceed this figure. The steel used in construction amounts to about 11,000 tons, which is held in place by more than two million rivets. This great weight, added to the lifting capacity of the



INBOARD PROFILE AND HALF-PLAN, SHOWING PUMPING MACHINERY.

dock, will represent a total displacement of about 30,000 tons at a draft of 16 feet 6 inches, but it is plain that for the dock to exercise its legitimate functions, a depth of water of above 50 feet will be required in order that a ship drawing 30 feet of water can float in over the keel blocks while the dock is submerged. At light draft the dock draws only 6½ feet.

The accommodations on the dock are designed for nine officers and twelve men, with state rooms and mess hall, a well-appointed galley, and a finely-equipped library.

The dock was constructed under the immediate supervision of Mr. Leonard M. Cox, Civil Engineer, U. S. N., working in conjunction with Mr. S. Anderson, Superintendent of the Dock Department, Maryland Steel Company.

The first test of the dock was made by means of the armored cruiser *Colorado,* which had at the time a displacement of 13,300 tons distributed over a length of about 500 feet. The ship was lifted clear of the water in 2 hours 16 minutes. A more severe test was that connected with the battleship *Iowa,* which had a displacement of 11,600 tons and a length on the keel blocks of about 330 feet. This ship was lifted clear of the water in 1 hour 37 minutes, but the pumping was continued until the dock had such a freeboard as to represent the raising of a 16,000-ton ship, which was accomplished in 2 hours 42 minutes altogether. In this latter case a deflection in the length of the dock was found amounting to about 2 inches, which had increased at the expiration of 48 hours to 4 inches, but which in the bearing length of the ship did not exceed 1¾ inches.

The self-docking test occupied about fifteen days, but it is expected that this time will ultimately be reduced to eight or ten days, which will be a record for this operation.

The dock is to be turned over to the Navy Department about the first of October, and arrangements will then be made for towing it to Olongapo, its ultimate destination. It is expected that the process of towing the dock this distance of some 13,000 miles will require about five months.

NOTES ON THE CALCULATION OF SIZE OF RUDDER STOCKS.

BY J. W. CLARY.

Empirical formulæ for calculating the diameter of the rudder stock of a vessel are given by most of the classification societies, and in the various shipbuilders' handbooks and text books of naval architecture. These formulæ show great differences in results, and in some cases, notably those of the formulæ given by the various classification societies, are applicable only to the form of rudder usually found on merchant vessels. In these notes an endeavor has been made to state the theory of these calculations, to give the results of tests from ships in service, and to derive formulæ which may be quickly applied and are sufficiently flexible to suit any case. In this connection the following authorities have been consulted:

Pollard et Dudebout—Theorie du Navire.

William F. Durand—Paper read at the seventh general meeting of the Society of Naval Architects and Marine Engineers, on "The Action of the Rudder."

L. Callou—Cours de Construction de Navire, 1902.

A. Croneau—Construction Practique du Navire de Guerre, 1894.

E. Gayde—Cours Practique de Construction Navale, 1895.

Paper read by Arthur J. Maginnis before Institute of Naval Architects, April 16, 1886, on "A New System of Steering Gear, and Rudder Strains Recorded by It."

And "Note au sujet du calcul du Moment Resistant des Gouvernails par M. de Courville." Bulletin de l'Association Technique Maritime, No. 7, p. 57.

It seems to be agreed that the best method of estimating the stress in a rudder stock and other fittings connected with the rudder is to calculate the pressure on the rudder blade and its moment about the axis of the stock by means of formulæ derived by Joëssel for the general action of water on planes moving obliquely to their normal, modified by a *coefficient of reduction* obtained by experiments on vessels under actual conditions of service. The number of these experiments is limited, the types of vessel on which they have been made differ widely and the speeds at which the experiments were made were, in the majority of cases, low, so that no actual figures for large, high-speed vessels are available; but from the data which exists coefficients of reduction can be taken which may be used with judgment.

It is true that the stresses on the rudder stock due to the shock of waves may be five or six times as great as the stresses due to putting the helm over in still water (S. S. *British Prince*—maximum pressure on gear to put rudder hard over 5.6 tons at 13 knots speed in calm, while springs were broken in indicators during a storm, showing at least 30 tons pressure) and that it is impossible to calculate these dynamic stresses; but in the majority of calculations of the strength of structures or members of a structure that are to support live loads or undergo any dynamic stresses, the calculations must be for statical stresses and a factor of safety applied to cover any stress that is likely to occur. Even if it is considered best to establish the size of the rudder stock entirely from the experience of the designer, a more or less standard form of calculation would serve as a basis of comparison (as is the case in calculations of statical stability and of strength of ships) and would be of value.

The theory of these calculations is well expressed in Theorie du Navire (Pollard & Dudebout), Tome IV., page 26, *et seq.*, a translation of which follows:

"To estimate approximately the resistance of a rectangular rudder with a vertical stock the formulæ for a thin plate, found by M. Joëssel, may be used, assuming that, in the relative movement of the ship and the water, the stream lines have a constant speed in relation to the rudder blade equal to the initial speed of the ship and parallel to its length. . . .

"But the hypothesis that has been made, that the direction and the velocity of the stream lines remain constant, limits the application of these formulæ to the almost useless case when a ship remains fixed, moored in a current with a velocity V_0, parallel to its keel and coming from ahead. But here would be the place to remark that the angle of incidence of the stream lines on the rudder blade is not equal to the helm angle α, but greater than this angle by a quantity which depends on the mean angle of the after part of the water-lines of the hull for the height of the rudder. Nevertheless, this influence of the form of the hull on the stream lines which strike the rudder blade can be neglected because this same form favors the return, in a horizontal direction, of the water to the back of the rudder blade and thus restores, more or less completely, on the back the excess of resistance which it has caused on the front. It is, besides, necessary to consider, especially if the stern is cut squarely as in the case of a barge, that the stream lines acting on the rudder would have their relative velocity diminished by the partial influence of the liquid mass.

"In reality, the rudder is not made for action on a ship moored in a current, but on a free ship, and then it causes a horizontal movement of the ship in a curved line. . . . Now this movement reacts on the action of the rudder and modifies its intensity by changing the direction of the stream lines which are about to strike the rudder blade. In other words, the above formulæ for the direct resistance and for the moment tending to return the rudder to a fore-and-aft position . . . are applicable only for a very short interval of time at the beginning where these quantities are still, if not very small, at least far from their maximum values, which alone interest us for the judicious determination of the dimensions of the various pieces used to swing the rudder blade (rudder stock, tiller, tiller ropes, wheels, mechanical apparatus, etc.).

"To solve the problem and to find, in the usual case of the free ship, the maximum reacting moment when the helm angle has reached the final value $\alpha = \alpha_1$, that it is desired to keep constant, it is necessary to study first the movement of the ship during the 'maneuvering period,' or, in other words, during the period while the rudder blade is swinging.

"We shall first notice that the formulæ (of M. Joëssel) applied for the definite angle α_1 will give too large results for the two following reasons:

"1. Admitting that at the end of the time used in swinging the rudder blade the ship would not yet have turned horizontally, the final speed V_1 in the direction of the keel would be less than the initial speed V_0 on account of the component of the additional resistance (of the rudder) in the direction of the keel.

"2. At the end of this period the ship has already acquired an angular velocity at right angles to the keel, which diminishes the angle of incidence of the stream lines on the rudder blade by a certain angle ε, and consequently the final moment tending to return the rudder to a fore-and-aft plane.

"It follows from this that the ratio of the actual final moment tending to return the rudder to a fore-and-aft plane to the moment given by M. Joëssel's formulæ for $\alpha = \alpha_1$, is equal to:

$$\frac{V_1^2}{V_0^2} \times \frac{\sin(\alpha_1 - \varepsilon)}{\sin \alpha_1} = Q.$$

This is the *coefficient of reduction* to be calculated, with which it is necessary to modify the results given by the formulæ if it is desired to know the actual final reacting moment, and the work which the helmsman or the steam engine must furnish to swing the rudder blade."

Following out this line of reasoning, Prof. Durand (Trans. Soc. Nav. Arch., Vol. VII, page 267, *et seq.*) takes the case of a vessel of 8,000 tons displacement, 400 feet long, 50 feet beam, 22 feet draft, area of rudder 200 square feet, extreme helm angle 35 degrees, time required to put helm over 10 seconds, speed 25 feet per second, or about 14 knots; and, by methods of his own for solving differential equations, calculates the value of the helm moment, showing the reduction, as compared with the value obtained by Joëssel's formulæ, due to the decrease in the angle of incidence of the water striking the rudder and in the speed; giving in this case a value of .64 for the coefficient of reduction. He also constructs various curves, of which one in particular shows the angle by which the effective angle of obliquity of the flow of water to the rudder (denoted in the foregoing translation by ε) is reduced, which, for the assumed case, amounts to 12.5 degrees at a maximum angle of 35 degrees.

Joëssel's formulæ for the pressure and its point of application on a rectangular plate submerged in a current are as follows:

$$P = 1.622 \frac{\sin \alpha}{.39 + .61 \sin \alpha} \cdot \frac{w}{2g} \cdot AV^2 \qquad \text{(a)}$$

$$x = (.195 + .305 \sin \alpha)\, b \qquad \text{(b)}$$

Where P = normal pressure on the plate in pounds.
A = area of plate in square feet.
V = velocity of current in feet per second.
α = inclination of face of plate to direction of current.
w = weight per cubic foot of water in pounds.
g = acceleration due to gravity in feet.
b = breadth of plate.
x = distance of center of pressure from forward edge of plate.

For V = speed in knots; $w = 64$ pounds, and $g = 32.16$ feet.

$$P = 4.6\, AV^2 \frac{\sin \alpha}{.39 + .61 \sin \alpha} \qquad \text{(c)}$$

For $\alpha = 35°$ (usual maximum helm angle) $\sin \alpha = .5736$.

$$P = 3.57\, AV^2 \qquad \text{(d)}$$

$$x = .37\, b \qquad \text{(e)}$$

The following table of coefficients of reduction, to be applied to the foregoing formulæ, obtained by experiment on vessels under service conditions, is taken from Prof. Durand's article (Trans. Amer. Soc. Nav. Arch., Vol. VII., page 279), to which have been added the results of trials on the *Condor* and *Epervier*, which may be found in Theorie du Navire (Pollard and Dudebout), Tome IV., page 36.

It will be seen that these coefficients (which represent the ratio of the actual twisting moment on the rudder stock to the moment as estimated by the formulæ) vary from .35 to .80 under conditions which are well stated in Theorie du Navire, Tome IV., page 37, discussing the results for the *Condor* and *Epervier:*

"The above table shows that for a given ship and for a given speed of maneuver (of the helm):

"1. When the time required to put the helm over remains constant the coefficient diminishes in proportion as the initial speed in a straight line increases, which agrees with the theoretical deductions. In other words, the actual final reacting moment increases much less rapidly than the square of the initial speed.

"2. When the initial speed in a straight line remains constant the coefficient decreases in proportion as the time required to put the helm over increases, which also agrees with the theoretical indications, although these indications have been found for a very small length of time and for a constant helm angle. . . .

"It is clear that for the same angular velocity of helm about the rudder stock, a ship of large mass, and, at the same time, very long and very fine at the ends, presenting, in a word, a great resistance to turning in relation to the power of its rudder, would lose, during a given time of maneuver of the helm, a smaller fraction of its initial speed, and would also acquire, during this time, a smaller drift angle, so that its coefficient of reduction would be greater than the above (for the *Condor* and *Epervier*), and its actual final reacting moment would approach more nearly the results given by the formulæ of M. Joëssel. Experiments have shown this, for dynamometric experiments made during turning trials of the *Amiral Baudin* by M. l'Ingenieur de la Marine de Courville have given for this ship, at an initial speed of 14 knots, coefficients of reduction amounting to 1.53 to 1.60 times those of the *Condor*."

Or, in other words, a small coefficient of reduction is associated with small vessels, relatively large rudder areas, high speed of ship, and low speed of helm, and a large coefficient is associated with large vessels, small rudder areas, low speed of ship, and high speed of helm.

Professor Durand says: "In the French naval designs the value .48 has been very commonly taken," and this is value corresponding to the constant given by Croneau for ships of 18 to 20 knots speed (Construction practique du Navire de Guerre, Tome second, page 455).

Callou, in his "Cours de Construction du Navire," of 1902, Tome second, page 125, says:

"According to actual practice the pieces for swinging the rudder are placed in such a way as to permit a maximum angle of inclination of between 30 and 35 degrees; sometimes, because of difficulties of installation, this is decreased to 28 degrees. This accomplished, the maximum pressure sustained by the rudder blade is calculated by means of the following formula:

$$P = \frac{KSV^2 \sin \alpha}{.195 + .305 \sin \alpha},$$

in which is substituted for V the value of the maximum designed speed of the ship, for α the maximum value permitted by the installation of the members controlling the rudder, and for K a value equal to 20 kilos, at least for speeds not far from 20 knots. However, on recent armored cruisers whose maximum speed varies from 21 to 23 knots, a slightly greater value of K has been adopted equal to 22.5 kilos."

As in Joëssel's formula, expressed in this form with French units, the value of K is 41.35 kilos; these values correspond to coefficients of reduction of .48 and .54, respectively.

The coefficient .48 seems to be based on the trial of the *Condor* and *Epervier*, which are small vessels of 1,272 tons displacement; the results for larger vessels give for the *Warrior* (8,695 tons, 11.04 knots, helm angle 25 degrees), .62; for the *Rodney* (10,300 tons, 16.9 knots, helm angle 34 degrees 30 minutes), .63; and for the *Amiral Baudin* (12,000 tons, 15 knots, helm angle 35 degrees), .80; which shows that .48 is much too small a coefficient for the ordinary case. M. de Courville, in his article, "Note au sujet du calcul du Moment Resistant des Gouvernails," Bulletin de l'Association Technique Maritime, No. 7, p. 57, gives a mathematical comparison between the results of the *Condor* and the *Amiral Baudin* to show that the coefficients obtained from the latter are what would be expected on account of the greater dimensions of the vessel, but since his method applied to the *Cassini* (960 tons displacement) would give smaller coefficients than for the *Condor*, while the actual results from trial are very

Ship.	Length. Feet.	Draft. Feet.	Displacement. Tons.	Area of Rudder. Square Feet.	Speed in Knots.	Helm Angle. Degrees.	Coefficient of Reduction.
Warrior (*a*)	380	26.6	8,695	180	5 92	25	.75
					8 88	25	.73
					11.04	25	.62
Messina (*b*)				31	8.75	40	.50
British Prince (*c*)				101	12.25	35	.68
				104	13.	35	.71
Rodney (*d*)	345	27.25	10.300	195	16.9	34.5	.63
Amiral Baudin (*e*)	328	25.9	12,000	207	15.17	35	.785
					14 72	35	.810
					14.72	33	.802
					14.10	34	.776
Cassini (*f*)	262	10.25	960	53.8	12.	20	.801
					12.	31	.562
					16.	20	.798
					16.	31	.535
					20.	20	.794
					20.	31	.517
Pothuau (*g*)	371	21.3	5,320	.....	17.8	34	.514
					18.2	33	.515
Monterey (*h*)	256	14.5	4,027	95.7	12.	35	.353
					10.	35	.343
					8.	35	.370
					6.	35	.459
					4.	35	.649
Condor and Epervier (*i*)	223	13.9	1,272	.....	6.	9	.792
					6.	18	.723
					6.	28	.704
					8.	9	.730
					8.	18	.650
					8.	28	.630
					10.	9	.675
					10.	18	.584
					10.	28	.570
					12.	9	.620
					12.	18	.528
					12.	28	.520
					14.	9	.565
					14.	18	.480
					14.	28	.478
					16.	9	.515
					16.	18	.443
					16.	28	.443
					18.	9	.465
					18.	18	.414
					18.	28	.412
					20.	9	.420
					20.	18	.389
					20.	28	.385

Breadth of rudder in feet: (*d*) 9, (*h*) 10.41.

Breadth of rudder in feet, assumed from other data given: (*a*) 7, (*b*) 3.4, (*c*) 4.5.

Angular velocity of helm in degrees per second: (*e*) 3, (*f*) about 2 5, (*g*) 2 to 2.5, (*h*) 1.5 to 2, (*i*) 3.

(*a*) Trans. Inst. of Nav. Arch., vol. v., p. 82.
(*b*) Trans. Inst. of Nav. Arch., vol. v., p. 115.
(*c*) Trans. Inst. of Nav. Arch., vol. xxvii., p. 358.
(*d*) Trans. Inst of Nav Arch., vol. xxvii., p. 358.
(*e*) Bulletin de la Soc. Tech. Maritime, vol. vii., p. 57.
(*f*) Bu letin de la Soc. Tech. Maritime, vol. viii., p. 215.
(*g*) Bulletin de la Soc. Tech. Maritime, vol. viii., p. 215.
(*h*) Trans. Soc. Nav. Arch. and Marine Engineers, vol. iii., p. 45.
(*i*) Pollard and Dudebout, Theorie du Navire, Tome iv., p. 36.

considerably larger, the method would seem to be made for the case in point. Comparing the *Rodney* with the *Amiral Baudin* it is to be noted that the former is a longer and deeper ship, has a smaller area of rudder in proportion to the lateral plane, and a smaller coefficient of fineness than the latter, all of which would tend to cause a larger reduction coefficient at the same speed; while an increase of two knots would not of itself account for a reduction in coefficient from .80 to .63. In general, in comparison with other ships, the *Amiral Baudin* seems to have a larger reduction coefficient than would be expected, but this fact shows that for large, slow ships a coefficient of .8 should be used for safety.

No definite reduction coefficients can be stated from the data at present available, but a coefficient must be chosen by judgment for each case, varying from .80 for a large, slow vessel, to .45 for a small, swift one. It would seem best, however, to use from .60 to .75 for modern battleships and cruisers, which is considerably in excess of the figure used in recent French practice (.54) as stated above; .55 to .65 for gunboats of 900 tons and upward; and .45 to .55 for torpedo boats and destroyers.

The pressure on the rudder and the twisting moment about the stock having been estimated, the only member that need be proportioned by calculation, for a rudder as ordinarily hung, is the stock, as the pintles when proportioned for bearing surface and symmetry will be amply strong to resist any shearing stress to which they may be subjected. In this case the stock should be calculated to resist a torsional stress; in the case of a rudder supported only by the stock the calculations should be for combined twisting and bending, assuming the center of pressure for bending at the center of area; in the case of a balanced rudder supported by the stock and by a pivot at the bottom, the pivot should be calculated for shearing, using half the total pressure as a load, and the stock for twisting and bending, using for a bending moment $\frac{Pl}{8}$, where P = the total pressure on the rudder and l = the distance between the points of support of the rudder. In other words, the rudder is assumed to be a beam fixed at the stuffing box and supported at the pivot.

The formula for the torsional stress in a shaft, $p = \frac{My}{I}$, where p = the allowable stress, M = the twisting moment, y = the distance of the outside fiber from the neutral axis, and I = the polar moment of inertia of a transverse section of the shaft, becomes for a solid circular shaft, solved for the diameter:

$$d = 1.721 \sqrt[3]{\frac{M}{p}} \qquad \text{(f)}$$

and for a hollow shaft:

$$\frac{d^4 - d_1^4}{d} = 5.093 \frac{M}{p} \qquad \text{(g)}$$

Where d = outside diameter in inches.
d_1 = inside diameter in inches.
M = twisting moment in inch pounds.
p = allowable stress in pounds per square inch.

For allowable stress on a steel stock, 7,500 pounds per square inch would seem a safe figure, giving a factor of safety of between 6 and 7, which is a customary allowance for structures subjected to live loads. For small, high-speed vessels such as torpedo boats, destroyers, fast yachts, etc., a larger value of p may be used, say 10,000 to 11,000 pounds, owing to the fact that while the stock is calculated for the rudder at a maximum angle at maximum speed, such a condition would never be realized except in smooth water. This fact is also the reason for choosing a safety factor suitable for a structure subjected to a live load rather than for one subjected to shocks. Using 7,500 pounds per square inch for p the formulæ **(f)** and **(g)** become:

$$d = .088 \sqrt[3]{M} \text{ for a solid stock} \qquad \text{(h)}$$

$$\frac{d^4 - d_1^4}{d} = \frac{M}{1,472} \text{ for a hollow stock} \qquad \text{(k)}$$

For combined twisting and bending use Grashof's formula:

$$p = \frac{d}{2I}\left(\frac{3}{8} M_1 + \frac{5}{8} \sqrt{M_1^2 + M_2^2}\right) \qquad \text{(l)}$$

Where M_1 = bending moment.
M_2 = twisting moment.
d = diameter of stock.
I = moment of inertia of section about a diameter.
p = allowable stress.

The following example will illustrate the method of making a calculation:

Given a rudder as shown in sketch, maximum helm angle 35 degrees.

Ship data:

L. B. P., 450 feet.
Draft, 24 feet 6 inches.
Beam, extreme, 76 feet 10 inches.
Displacement, 16,000 tons.
Speed, 18 knots.

Rudder must be put hard over from amidships in 10 seconds.

For this case a reduction coefficient of .70 may be used.

Divide the rudder into rectangles as shown, and combine the areas to find the center of pressure of the whole. Applying formula **(e)** for center of pressure, $x = .37\,b$, and taking moments about the axis of the rudder,

AREA		ARM		MOMENT
13.2	×	11.9	=	157.
150.2	×	5.24	=	787.
122.1	×	.98	=	120.
285.5		3.73		1,064

Total area = 285.5 square feet, center of pressure 3.73 feet = 45 inches aft of axis.

Then by **(d)** applying the reduction coefficient

$$P = .7 \times 3.57\,AV^2 = .7 \times 3.57 \times 285.5 \times 324 = 231,162 \text{ pounds.}$$

Twisting moment = 231,162 × 45 = 10,402,290 inch pounds.

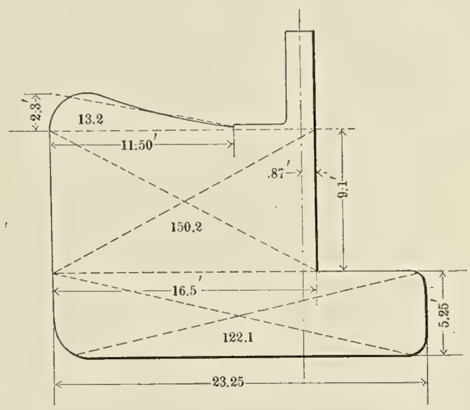
For a solid stock by **(h)**

$$d = .088 \sqrt[3]{M} = .088 \sqrt[3]{10,402,290} = 19.2 \text{ ins.}$$

The stock is to be hollow with at least a 5-inch bore.

For a hollow stock by **(k)**

$$\frac{d^4 - d_1^4}{d} = \frac{M}{1,472} \text{ assume } d = 19.25 \text{ inches.}$$



SKETCH OF BALANCED RUDDER.

Then

$$\frac{137,344 - d_1^4}{19.25} = \frac{10,402,290}{1,472},\ d_1^4 = 137,344 - 136,035 = 1,309,$$

$$d_1 = 6 \text{ inches.}$$

Therefore, the rudder stock should be 19¼ inches outside diameter, with a bore not exceeding 6 inches.

It will be of interest to compare the above result with the results of various empirical formulæ.

A formula much used in French practice is, for an iron stock, reduced to English units,

$$d = 1.2 \sqrt[3]{KM}.$$

Where d = diameter of stock in inches.
M = moment of area of rudder about the axis.
K = a coefficient which is 1.1 for 14 knots, and varies proportionately with the square of the speed.

This formula applied to the above rudder gives:

$$d = 17\tfrac{3}{4} \text{ ins.}$$

Lloyd's formula is:

$$d = \sqrt[3]{D \times B^2 \times S^2}.$$

Where d = diameter of stock in inches.
D = draft in feet.
B = breadth of rudder in inches.
S = speed in knots.

This formula gives:

$$d = 21 \text{ ins.}$$

A later formula of Lloyd's is:

$$d = \sqrt[3]{D \times b\,(2B - b) \times S^2}.$$

Where b = maximum breadth of rudder in inches.
B = greatest distance from center of pintles to back of rudder in inches.
Other letters as above.

This formula in this case is practically the same as the other. Lloyd's tables, as well as the rules of the American Bureau of Shipping, give 11 inches for diameter of rudder stock for a ship of this number, which shows that these formulæ are not adapted to rudders of this shape, but only to those of merchant vessels where the breadth of the rudder is not nearly so great in proportion to the area.

The rules of the British Corporation for the Survey and Registry of Shipping give:

$$d = .26\,\sqrt[3]{R.A.V.^2}.$$

Where d = diameter of stock in inches.
R = distance of center of gravity of rudder area from the axis of the stock, in feet.
A = area of rudder in square feet.
V = speed of vessel in knots.

This would give for the diameter of stock for the assumed case 23½ inches, which shows, as in the two previous cases, the inadaptability of the formula to a rudder of other than the ordinary shape.

Mackrow, page 314, edition 1902, gives a formula for strength of rudder head for a maximum rudder angle of 35 degrees.

$$D = .392\,\sqrt[3]{\frac{AU^2d}{K}}.$$

Where D = diameter in inches.
A = immersed area of rudder in square feet.
U = speed of ship in knots, allowing 10 percent slip.
d = distance of center of effort from axis of rudder in feet.

NOTE—For angles at or about 35 degrees the center of effort is situated ⅛ of the breadth of the rudder before the center of gravity of the area.

K = a coefficient of 5 for cast steel, 4 for wrought iron, and 3 for phosphor bronze.

For this case the above formula becomes:

$$D = .392\,\sqrt[3]{\frac{285.5 \times 392 \times 4.08}{5}} = .392\,\sqrt[3]{91{,}323}$$
$$= .392 \times 45$$
$$= 17.64 \text{ inches.}$$

Mackrow, page 176, edition 1902, gives a formula for twisting moment on the rudder stock:

$$M = 1.12\,AV^2d \sin\theta$$

Where M = twisting moment in foot pounds.
A = area of rudder in square feet.
d = distance from axis of rudder to center of pressure as above in feet.
θ = helm angle.
V = 1.1 times speed of ship in feet per second.

This becomes for the rudder, assumed:

M = 835,034 feet pounds, as compared with 862,234 feet pounds from the modified Joëssel formula.

Attwood, Text Book of Theoretical Naval Architecture, pages 265 and 266, uses the foregoing formula and calculates the size of rudder stock with this moment, allowing a stress of 5 tons per square inch for cast steel, which seems rather in excess of the limits of safety.

It is to be observed that this formula for total pressure on the rudder, *i.e.*, $1.12\,AV^2 \sin\theta$, becomes, when V is expressed in knots and is taken as the speed of the vessel, the 10 percent allowance being made in the form of a coefficient, and $\theta = 35$ degrees:

$$1.12\left(\frac{6{,}080}{3{,}600}\right)^2 A\,(1.1\,V)^2 \times .5736,$$

$= 2.20\,AV^2$, which corresponds to formula **(d)** modified with a reduction coefficient of .62, and is a good formula for the average case.

The formulæ **(b)**, **(c)**, and **(f)** or **(g)**, may be applied with but little more trouble than any of the above, and have the advantage of being more general; if the conditions are such that formulæ **(d)**, **(e)**, and **(h)** may be used the work of applying them is practically no more than in the case of the other empirical formulæ, and a reduction coefficient may be chosen to suit the given conditions.

I might also state a point possibly not perfectly apparent, that the center of pressure of a rudder having a curved outline may be found in the same manner as the center of gravity, by Simpson's, or other rules for integration, by applying the proper factor (as for instance .37 for an angle of 35 degrees) to the squares of ordinates instead of the factor ½.

Finally, while as has been previously stated, this method of calculation may be of use only as a standard of comparison, as far as the size of the rudder stock is concerned, owing to the unknown forces which act on the rudder in a seaway, it is of direct value in proportioning the steering engine, since the power to be furnished by the latter is a function of the maximum twisting moment on the rudder stock, and is not affected by the shock of the waves.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, report under date of September 11, 1905, the following percentage of completion of vessels building for the United States Navy:

			Aug. 1	Sept. 1
BATTLESHIPS.				
Virginia	19 knots.	Newport News Co.	91.37	92.89
Nebraska	19 "	Moran Brothers Co.	77.	79 58
Georgia	19 "	Bath Iron Works.	85.	86.44
New Jersey	19 "	Fore River Shipbuilding Co.	87.7	89.3
Rhode Island	19 "	Fore River Shipbuilding Co.	92.1	93.
Connecticut	18 "	Navy Yard, New York, N. Y.	83.67	86.15
Louisiana	18 "	Newport News Co.	82.81	86.4
Vermont	18 "	Fore River Shipbuilding Co.	57.1	61.4
Kansas	18 "	New York Shipbuilding Co.	57.8	60.1
Minnesota	18 "	Newport News Co.	69.9	71.16
Mississippi	17 "	Wm. Cramp and Sons.	34.48	38.71
Idaho	17 "	Wm. Cramp and Sons.	31.22	33.66
New Hampshire	18 "	New York Shipbuilding Co.	15.2	18.2
ARMORED CRUISERS.				
California	22 knots.	Union Iron Works	80.4	81.8
South Dakota	22 "	Union Iron Works.	78.9	80.6
Tennessee.	22 "	William Cramp and Sons.	82.02	84.32
Washington	22 "	New York Shipbuilding Co.	82.03	83.9
North Carolina	22 "	Newport News Co	12.2	14.96
Montana	22 "	Newport News Co	10.81	13.04
SEMI-ARMORED CRUISERS.				
St. Louis	22 knots.	Neafie and Levy Co.	71.4	75.7
Milwaukee	22 "	Union Iron Works.	79.	80.6
Charleston	22 "	Newport News Co.	99.	99.7
SCOUT CRUISERS.				
Chester	24 knots.	Bath Iron Works.	0.	0.
Birmingham	24 "	Fore River Shipbuilding Co.	0.	4.7
Salem	24 "	Fore River Shipbuilding Co.	0.	4.3
TRAINING SHIPS.				
Cumberland	Sails....	Navy Yard, Boston.	95.	95.
Intrepid.	"	Navy Yard, Mare Island	97.5	97.5
TORPEDO BOATS.				
Goldsborough	30 knots.	Wolff and Zwicker.	99.	99.
O'Brien	26 "	Lewis Nixon.	99.	99.
SUBMARINE TORPEDO BOATS.				
Submarine No. 9	.....	Fore River Shipbuilding Co.	12.6	17.6
" " 10	.....	Fore River Shipbuilding Co	11.5	16.5
" " 11	.....	Fore River Shipbuilding Co	11.5	16.5
" " 12	.....	Fore River Shipbuilding Co	11.5	16.5

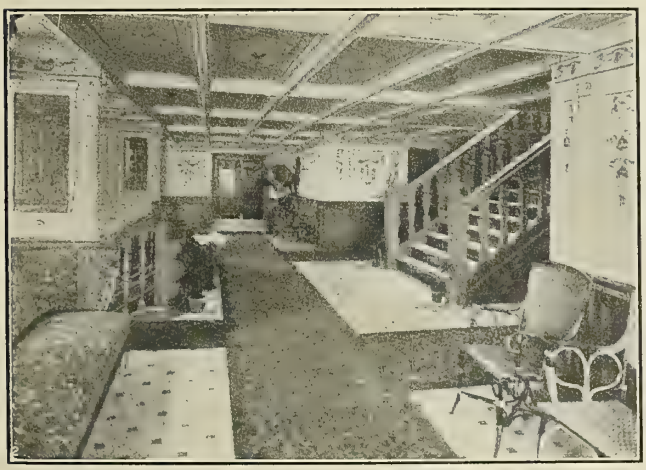
The New Steamer Aragon.

BY BENJAMIN TAYLOR.

We present a photograph of the British Royal Mail Steam Packet Company's new twin-screw mail steamer *Aragon,* recently launched from Harland & Wolff's yard at Belfast.

LAUNCHING OF STEAMSHIP ARAGON.

This steamer is not only the finest vessel in the R. M. S. P. fleet, but will be the largest and finest steamer engaged in the South American trade. Her dimensions are: length, 527 feet 6 inches; beam, 60 feet; gross register, about 10,000 tons. The *Aragon* is designed to carry a large quantity of cargo, but splendid passenger accommodation is provided. The state rooms are on deck, which is an improvement, and many of the cabins are arranged on the tandem principle, with side lights for each room.

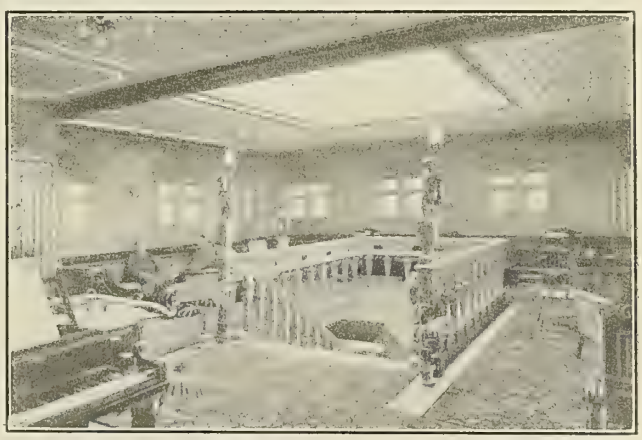


ENTRANCE HALL, WITH STAIRWAY TO PROMENADE DECK.

There are a number of suites de luxe, furnished in white and gold with silk panelings. The first-class dining saloon is one of the handsomest afloat. The tables, seating 210 passengers, are arranged on the latest restaurant system. The elegance of the whole structure, combined with the magnificent stairway and approach to the main deck forms a fine example of marine architecture. The style is renaissance, in white oak and gold furnishings, adorned with cupids and sea trophies. The dome, modeled after that of the Genoese palace, is ornate and brilliantly lighted. The decorations of the library and music room situated on the promenade deck are in satinwood, the structure being surmounted by a dome of stained glass. The smoke room, well ventilated, is on the promenade deck aft, decorated with mural paintings and wainscoted in oak, while two doors open on a veranda extension fitted with tables. A nursery adjoins the first saloon on the main deck. The second-class accommodation, which compares favorably with first-class on the ordinary liner, includes handsome dining saloon, drawing and smoke rooms on deck, and ample promenade accommodation. The third-class accommodation provides for a large number of passengers in a style unsurpassed on any route.

Every provision has been made for the safe navigation of the steamer, and by the adoption of Harland & Wolff's latest balanced quadruple type of engines vibration is reduced to a minimum. The double set of engines for the twin screws constitutes, of course, an additional element of safety. The new ship is a schooner-rigged vessel with two masts, and has graceful lines and a fine appearance. She is a tribute to the high hopes entertained by the R. M. S. P. Company of the future of the South American trade.

By the launch of the *Aragon,* which started on her maiden voyage on June 14, and is almost double the size of the largest steamer hitherto possessed by the company, the directors have given evidence of their determination to keep ahead of the times.



SOCIAL HALL ON STEAMSHIP ARAGON.

One of the practical difficulties they have had to contend with was that they could rely upon only 22 1-2 feet of water at Buenos Ayres, which fact has hampered shipbuilders in designing large vessels suitable for the trade, but the progress of Argentina and the progressive policy of its government justifies the hope that before very long this question of providing a deeper channel for the port of Buenos Ayres will be settled.

THE PASSENGER AND FREIGHT SCREW-STEAMER KONG HAAKON.

BY DR. ALFRED GRADENWITZ.

The screw steamer described in the following has been built by the Eiderwerft Aktien Gesellschaft shipyard of Tönning, Germany, to the order of the Stavanger (Norway) Steamship Company, and is intended mainly for conveying passengers and mail between the various coast stations along the Christiania-Bergen route. Every care has accordingly been taken to serve the comfort and safety of passengers.

The *Kong Haakon*, as the ship is named, has been designed as a hurricane-deck ship, there being a lower deck in both holds. The ice-breaking resistance is provided for in an especially effective manner by intermediate frames running up to the front boiler-room bulkhead, as well as by re-enforcements of the outside planking at the water-line as far as the stern post. Five bulkheads divide the ship into six watertight compartments. Beneath the holds, as well as under the engine, there is a double bottom designed as a ballast tank. The ship has an elliptical stern and a straight stem. The hurricane deck has been made as wide as possible, both in the front and rear parts, with a view to increasing the available room. The ship is rigged as a pole-mast schooner.

On the promenade deck is a teak deck house containing in front the chart room and in the rear a smoking saloon. On the hurricane deck is the iron deck house, to the rear the ladies' saloon, a staircase leading down to the first-class rooms and a larger smoking saloon, while another staircase to the first-class rooms is located in front of the boiler casing. In the two side houses on the hurricane deck are the officers' rooms, two cabins, a post office, and the parcel-post room. Below the hurricane deck is placed to the rear the dining saloon, in front of which a spacious hall as well as a first-class cabin are located, in addition to the captain's and steward's rooms. In the front part of the ship are the second class, and below these the third-class passenger rooms.

All the rooms, including the decks, are lighted by electricity, in addition to which the saloons are provided with artistic silvered oil lamps. All state rooms are provided with steam heating. A projector of 10,000 normal candle power is placed on deck. As to loading and unloading devices, the ship has for the front hatchway a steam winch of 150 mm. (6-inch) cylinder diameter and 250 mm. (10-inch) stroke, the lifting power being 2½ tons, together with a derrick fitted to the mast. For the rear hatch has been provided a steam crane of 2-tons lifting capacity. In addition to this, the ship has a strong windlass, and in the stern a capstan for warping, both being operated by steam. As she is compelled in the fjords very frequently to sail in narrow channels, special care has been bestowed on the construction of the steam steering gear. The ship carries two lifeboats of seamless steel 6.7 m. (22 feet) in length, two wooden lifeboats 6.1 m. (20 feet) in length, and a sailing boat of 5.5 m. (18 feet) length, which are all fitted up according to the regulations of the board of trade.

THE SCREW STEAMER KONG HAAKON.

There are 23 first-class passenger cabins on board, containing 78 berths. Moreover, all the saloons are provided with sleeping sofas, so that the ship affords sleeping accommodations for at least 120 first-class, 24 second-class, and 16 third-class passengers. The dimensions of the ship are as follows:

Length between the perpendiculars	59.26 m. (184.0 ft.)
Maximum breadth over frames	8.69 m. (28.5 ft.)
Depth from upper edge of keel to main-deck stringer	4.29 m. (14.1 ft.)
Height from main deck to hurricane deck	2.30 m. (7.5 ft.)
Height from hurricane deck to promenade deck	2.30 m. (7.5 ft.)
Carrying capacity with 4.12 m. (13.5 ft.) draft above upper edge of keel	370 tons
Guaranteed speed with 3.66 m. (12 ft.) draft above upper edge of keel	13.25 knots
Displacement with same draft	993 c. m. (978 tons)
Coefficient of displacement	0.527

Both the stern post and rudder frame are made of steel castings, the rudder being double plated. The bottom of the ship as well as the bilges are lined with cement, all sharp places at the ends of the ship being filled with coke and lined with cement.

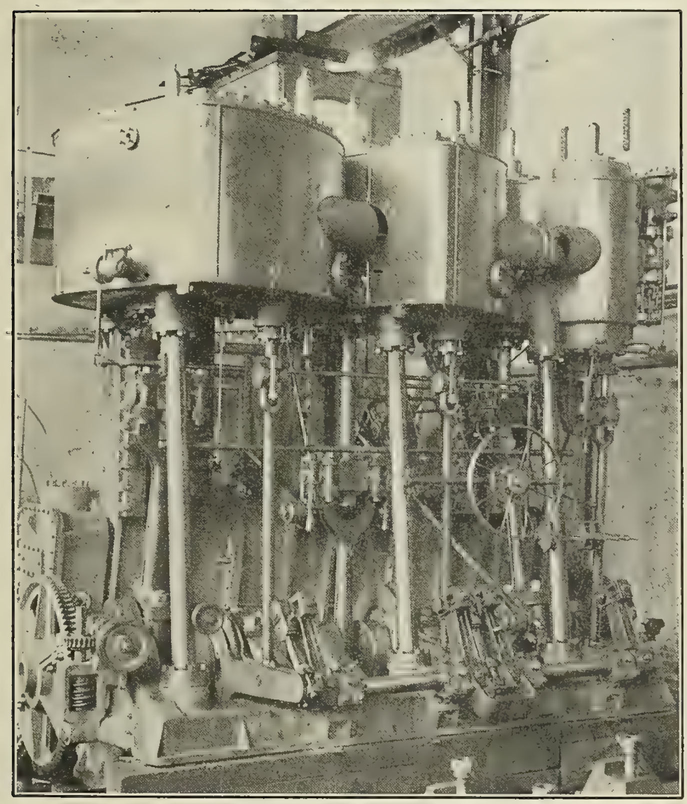
The main engine has been designed as a triple-expansion engine of the following dimensions:

Diameter of high-pressure cylinder	480 mm. (18.9 inches)
Diameter of medium-pressure cylinder	770 mm. (30.3 inches)
Diameter of low-pressure cylinder	1,270 mm. (50.0 inches)
Common stroke of all	750 mm. (29.5 inches)

During the official trials in the Eckernförde Bay a mean speed of 13.52 knots and 1,196 indicated horsepower was recorded with 113 revolutions per minute.

Owing to the shortness of the available engine room the engine has been fitted with Marshall valve motion. The cylinders are substantially screwed to each other and fitted with steam jackets, excepting the low-pressure cylinder. The steam inlet pipe of the medium-pressure valve chest has been designed as a compensation stuffing box, while between the medium- and low-pressure slide valve chests a compensation lens has been arranged. The high-pressure cylinder has been cast in one piece with the corresponding valve chest, while the remaining cylinders have separate valve chests. The pistons are made of cast iron, and are conical in form.

The surface condenser has a cooling surface of 130 square meters (1,400 square feet), the cooling pipes being of tin-plated rolled brass, 19 millimeters (0.75-inch) in external diameter. On the front part of the condenser, which consists of three parts, is located the reversing engine of 135 millimeters (5.4-inch) cylinder diameter and 130 millimeters (5.2-inch) stroke, operating in the usual way through worm and worm wheel, the weight shaft located on the opposite side. The steel crank shaft consists of three interchangeable parts and is 244 millimeters (9.6 inches) in diameter. The two intermediate shafts, each of which is 5,700 millimeters (18.7 feet) in length are 232 millimeters (9.2 inches) in diameter. The screw shaft is 6,000 millimeters (19.7 feet) in



THE TRIPLE-EXPANSION MAIN ENGINE.

length and 268 millimeters (10.5 inches) in diameter, and runs in renewable cast-iron boxes consisting of two parts and lined with pewter. The screw is made of cast iron to which aluminum is added; it has four blades, is 3,300 millimeters (10.8 feet) in diameter, with a pitch of 4,350 millimeters (14.3 feet); thus, 1.32 is the pitch ratio.

The pumps are fitted to the second third of the condenser and are operated from the cross head of the medium-pressure cylinder by means of a swinging lever. In addition to an air pump of the Edwards system, a double-acting circulating pump, two Lenz pumps, and two feed pumps have been provided, the common stroke of the three latter being 460 millimeters (18.1 inches).

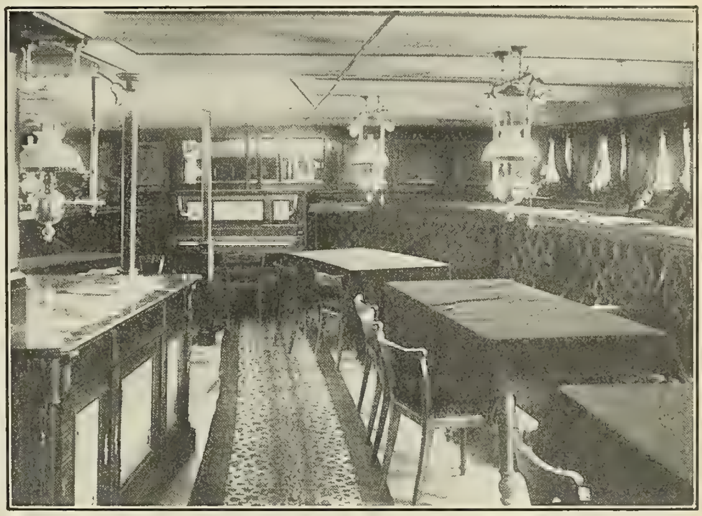
To feed the boiler at sea a Weir pump situated on starboard side is used, which is so designed as to make only eleven double strokes per minute with the maximum output of the engine. The two feed pumps before mentioned serve as reserve. In addition there is on the starboard side a bilge pump of 80-tons hourly output, and a donkey pump, being large enough to feed both boilers under forced draft. The feed pump for the auxiliary boiler, and the injectors, are arranged in the boiler room.

The electric-light engine has likewise been located on starboard side, and consists of a compound engine of 150 and 260 millimeters (6 and 10.3 inches) cylinder diameter, 160 millimeters (6.3-inch) stroke, and 300 revolutions per minute; it is direct-coupled to the direct-current dynamo.

The two main boilers are located one behind the other in the boiler room and are worked at 13 atmospheres (190 pounds per square inch). Each of them has three corrugated furnaces, the dimensions being as follows:

Length	3,445 mm. (11′ 3½″)
Diameter	3,960 mm. (13′)
Diameter of furnaces	980 mm. (3′ 2½″)
Number of tubes	112
Inner diameter of ordinary tubes	80.5 mm. (2.64″)
Outside diameter of ordinary tubes	89 mm. (2.92″)
Number of stay tubes	102
Inside diameter of stay tubes	77 mm. (2.53″)
Outside diameter of stay tubes	89 mm. (2,92″)
Heating surface	148 sq. m. (1,590 sq. ft.)
Grate surface	4.29 sq. m. (46.2 sq. ft.)
Ratio	34.5 to 1

The boilers are of mild Siemens-Martin steel, the strength required for the shell being more than 27 and less than 32 tons per square inch, the extension being at least 20 percent.



THE SALOON, LOOKING AFT.

The auxiliary boiler is on the starboard of the boiler room, and has been designed on the Victoria type for 8.4 atmospheres (123 pounds per square inch), the dimensions being as follows:

Height	2,743 mm. (8′ 4½″)
Diameter	1,600 mm. (4′ 10½″)
Number of fire tubes	77
Heating surface	16 sq. m. (172 sq. ft.)
Grate surface	1.48 sq. m. (15.9 sq. ft.)
Ratio	10.8 to 1

Staybolt Diagram.

BY H. S. BRITT.

The accompanying diagram embodies the rules of the U. S. Steamboat Inspection Service for flat surfaces supported by screw staybolts. The heavy dot-and-dash curves show the maximum pitch for any particular plate thickness and pressure, as determined by the following formula:

$$P = k\,\frac{t^2}{p^2},$$

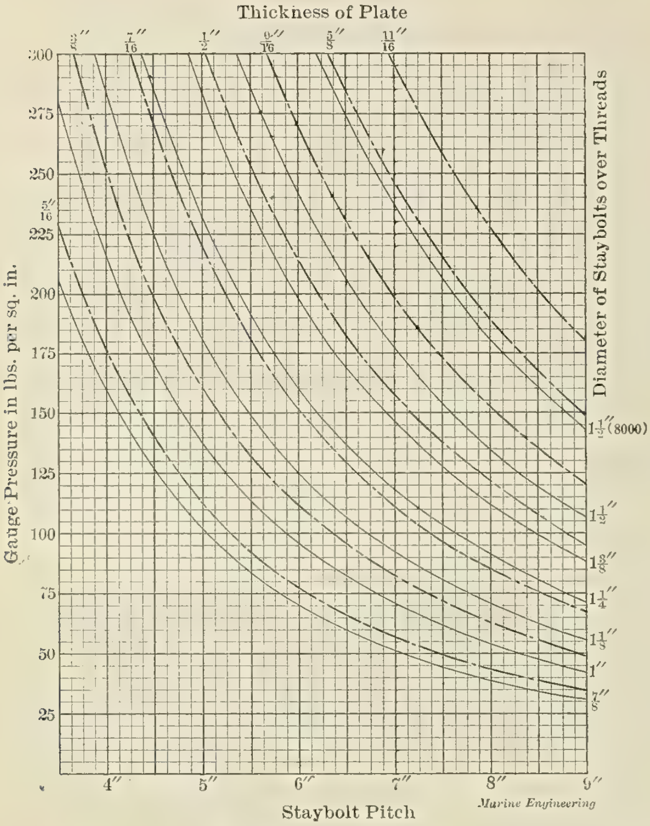
where P = allowable working pressure,

t = plate thickness in sixteenths of an inch,

p = maximum staybolt pitch,

and k is a constant having the value of 112 for plates 7-16 inch thick and under, and the value of 120 for plates above 7-16 inch.

The fine curved lines are for the determination of maximum staybolt pitch as dependent upon the strength of the staybolt.



These lines, with the exception of the one marked 1 1-2 inches (8,000), are plotted for the following conditions: staybolts in rectangular rows pitched the same distance apart vertically and horizontally; stress per square inch of cross-sectional area of a staybolt, 6,000 pounds; 12 threads per inch; sharp V-threads. For the curve marked 1 1-2 inches (8,000) the conditions are the same, except that 8,000 pounds per square inch is used for the unit stress, this higher value being allowed by the United States rules for staybolts over 1¼ inches diameter at bottom of thread if tested by the inspector before being used.

In case the pitch of the staybolts is not the same vertically and horizontally, the greater of the two pitches must not exceed the maximum for the given plate thickness, as found by the use of the heavy dot-and-dash curves; and the product of the vertical and horizontal pitches must not exceed the square of the maximum pitch for the given size of staybolt, as found from the diagram.

Trial Trip of the Sea-Going Suction Dredge St. John.

The dredge *St. John*, which has had, near Sandy Hook, a three-days' successful demonstration of her sea-going and dredging qualities, is the first of two vessels constructed by the James Reilly Repair and Supply Company for the United States Corps of Engineers.

The *St. John* was built to dredge sand from the mouth of the St. John River, Florida. The vessels have wooden hulls and have the general appearance of a coastwise steamship. The suction pipes are 18 inches in diameter, swiveling amidships, and are constructed so that they can be lowered or inclined at the free ends where heavy scraper nozzles are attached. These dredge the bottom of the harbor, and sand is pumped up by means of powerful centrifugal sand pumps which discharge the heavier material into bins constructed in the hold of the vessel. These bins have a capacity of 1,600 tons and can be filled in about forty-five minutes. The dredges are self-propelling, and when under way the suction pipes are drawn up and the vessel proceeds to sea, where the sand is discharged through numerous sluices in the bottom of the hull. The dredges are 200 feet long, 40 feet beam, 23 feet 2 inches depth, and have each two large Scotch boilers furnishing steam for about 2,000 horsepower. The engines are of the vertical inverted compound type, of about 1,200 horsepower. The pumping machinery on each vessel consists of two centrifugal pumps driven by a vertical inverted compound engine of about 700 horsepower. The vessels have in addition the usual auxiliary machinery fitted to regular steamships, and will each carry a crew of thirty-six men. They are lighted by electricity and are generally fitted out in a first-class manner.

LAUNCHING OF THE SUCTION DREDGE ST. JOHN.

MOTOR BOATS, IV.

BY DR. WILLIAM F. DURAND.

THE MOTOR-BOAT ENGINE.—(*Continued.*)

Ignition. For the purpose of igniting the charge, present-day practice is divided between the so-called "make-and-break" or contact spark, and the jump spark. In the former the spark is formed between two metallic points in the circuit of a spark coil, which are brought together and then "broken" or quickly separated. The jump spark, on the other hand, is formed between two stationary points which are in the circuit of the secondary of an induction coil. Contact being then made in the primary coil at the proper instant in the stroke a stream of sparks plays between the two terminals on the secondary circuit located within the cylinder and separated by a distance of about 1/16 inch. The contact spark requires moving parts within the cylinder, while the jump spark does not. With both forms trouble may arise due to corrosion or wear on the points, or to their becoming covered by deposits of a gummy carbonaceous matter. In special designs of make-and-break devices various means are in use to

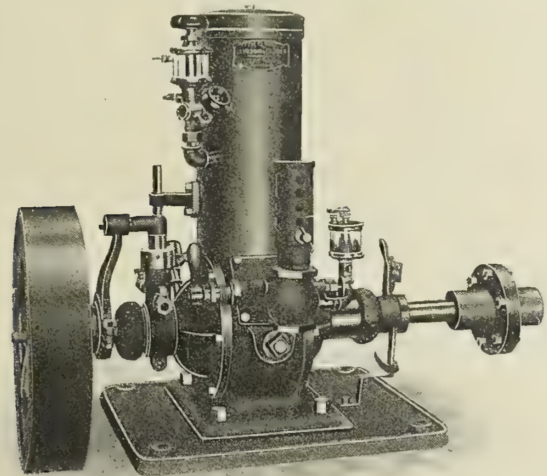


FIG. 28.—SINGLE CYLINDER, TWO-CYCLE "LAMB" ENGINE.

provide or permit a gradual shifting of the actual sparking surfaces so as to distribute the wear over a considerable surface and thus increase the durability of a given set of "points." With both forms of device the time at which the spark shall pass relatively to the position of the piston may be varied by an adjustment of the connections controlling the operation of the sparking gear. It is usually claimed by the advocates of the "jump" system that this adjustment is more readily effected than by the "make-and-break" system, and that the resultant speed range is wider; and also that the sparking points carried in an easily removable plug are more readily examined or replaced. There seems to be foundation for this claim and it must be admitted for most cases of high speeds and large power, as well as where readiness of handling and range of speed are of importance, that the jump spark is usually employed.

Cooling. Due to the high temperature of the products of combustion, the walls of the cylinder tend to become heated beyond the point of practicable lubrication, resulting in the rapid cutting and scoring of the bearing surfaces of the piston and cylinder. To prevent this the excess heat in the metal is removed by surrounding the working parts of the cylinder by a water jacket, as indicated in the various cuts. In the best practice of the day provision is made for independent expansion between the inner cylinder or liner and the outer cylinder or barrel, in order that the former may expand and contract without constraint from the latter. In many cases of excellent design, furthermore, the jacket is made by a brass shell fitted over the cylinder casting, which is accurately turned on both inside and outside, thus insuring uniformity of thickness in both parts of the structure, uniformity of temperature about the entire circumference of the cylinder, and, in consequence, a true circular form—a result scarcely possible with a cast-iron structure in one casting, with its inevitable variations in thickness from one point to another. The cooling water is usually provided by a small reciprocating plunger operated by an eccentric on the main or valve cam shaft. In some cases, however, rotary pumps have been used with good results. It may be noted at this point that it is possible to carry the cooling action too far as well as not far enough. In the latter case there is, of course, danger of mechanical injury to the piston and cylinder. In the former too much heat may be removed from the cylinder, and its efficiency as a heat engine may thereby be decreased.

Lubrication. For lubrication of the crank pin, designers of the two-cycle engine have found the splash system a simple and ef-

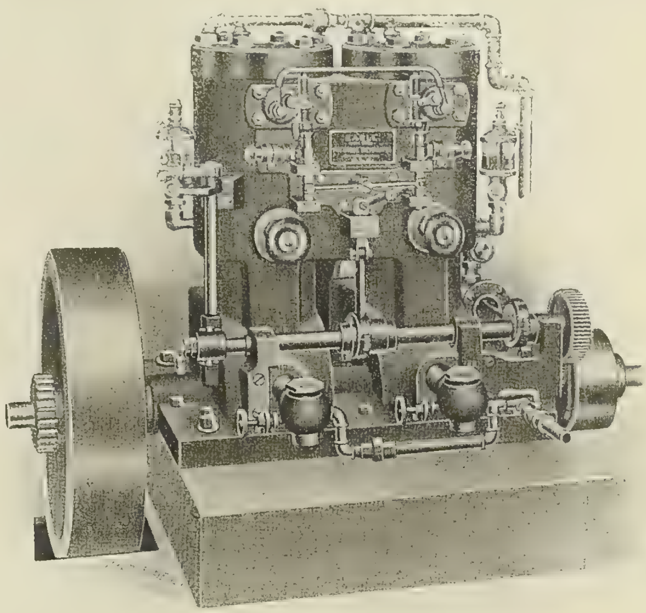


FIG. 29.—TWO CYLINDER, TWO-CYCLE, 10 H.P. "EAGLE" ENGINE.

fective means. The bottom of the crank case is filled with oil to such a point that the crank will splash the oil as it goes around, and thus receive a supply of lubricant. The same general source is also usually depended on to supply lubricant for the piston and for the upper end of the connecting rod as well. The chief objection to this mode of lubrication is found in the fact that the charge of vapor passing from the crank case to the cylinder will carry with it some small amount of lubricating oil. This in the cylinder will become burned, producing a charred or semi-viscid residue, which in time may clog the passages or cover the sparking points. Due to this fact some of the most recent designs show special means for oiling the cylinders and the parts within the crank case at stated times or at will, and by special adaptation of the means commonly employed in general engineering practice. For the other bearings and moving parts of the engine, compression grease cups, sight feed cups, and other similar means common to the engineering practice of the day are employed.

Speed Control. For purposes of speed control some combination of two general means is employed. These are:

(1) Control by throttling the amount of mixture introduced per stroke, and hence of the resulting work which can be developed.

(2) Control of the instant of sparking relative to the position of the piston, thus modifying the power which will be developed by a given charge. Reference to the form of indicator card given in the introductory chapter and to the description of the operation of the engine will show that at some one point the card

corresponding to a given charge will have the largest possible area. Retarding the spark beyond this point will then give a card of which Fig. 30 may be taken as a typical illustration. In some cases use has been made of an impoverishment of the mixture by increasing the amount of air. This, however, is not to be recommended, as it is less certain and satisfactory than a suitable combination of throttle and spark control.

In cases where the engine is connected to the propeller shaft through a reversing clutch, and where in consequence the engine may be running without load, the throttle, in the best designs, is placed under the control of an automatic governor of the centrifugal type, thus placing the speed under limitation with any and all conditions. Where the engine is multi-cylinder and of the so-called reversing type, the engine is connected direct to the propeller shaft, and is thus under load at all times. In such cases the engine is therefore controlled by hand throttle as in the steam engine.

Reversing and Handling. For reversing the thrust of the propeller with the internal combustion marine motor there are three methods at hand:

(1) Reversing the obliquity of the propeller blades.

(2) Reversing the direction of rotation of the propeller shaft by a mechanical reverse located between the engine and the shaft.

(3) Reversing the direction of the engine itself.

Further reference to Number (1) will be deferred to the general topic of the propeller.

The mechanical reverse gear is usually some form of the well-known "box of gears" or "jack-in-the-box" type. It operates in such manner that when in the go-ahead motion the engine is coupled direct to the propeller shaft, and the entire arrangement operates as a solid coupling, and, of course, without waste of power. When in the reverse motion, the engine drives the shaft through the gears, by the operation of which it is reversed in direction, and with the resulting slight loss due to the friction and wear in the gears. For engines of small or moderate size this form of reverse has generally commended itself to designers, and in one form or another is quite commonly employed. In large sizes, however, it is preferable to reverse the engine itself, as in the steam engine, and in certain cases of recent design the reverse is effected in this manner. It is clear that an internal

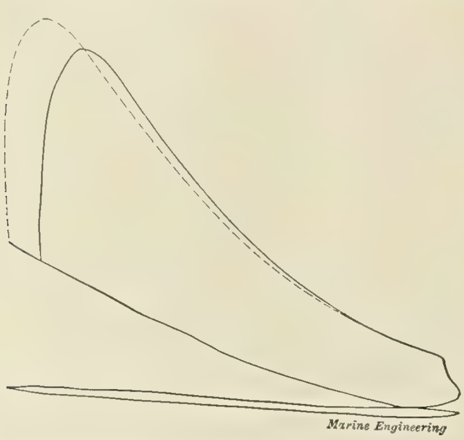


FIG. 30.—INDICATOR CARD WITH RETARDED SPARK. DOTTED LINE SHOWS NORMAL CARD.

combustion engine is as ready to run in one direction as the other, and that it requires only the proper adjustment of valve gear and sparking instant, together with an initial impulse, to start in either direction. In such form of reverse, then, the angular position of the cams operating the valves and the spark advance are both under lever control in such manner that from a mid-position the lever may be moved in either direction, thus placing the valves and spark in suitable relations for operating in one direction or the other according to the position of the lever. The initial impulse may then be obtained in the usual manner for starting and the engine will continue in the same direction. While this mode of reverse requires some additional features in the mechanism of the valve gear, still it must be considered as the most satisfactory in general principle, and in operative detail, except perhaps for engines of the smallest size. It may be added, however, that in order that this mode of reverse may be able to demonstrate its full value for rapid backing and filling, it should be used in connection with an auxiliary starting arrangement of some effective type. A typical arrangement of this character includes a small auxiliary air-compressor pump and receiver, with throttle and connections, with the compression space in the cylinders of the engine. At the will of the operator the compressed air may then be turned into the cylinder or cylinders just near or beyond the point of maximum compression, and thus the engine may be started as readily and in the same manner as with steam. The compressor may be so arranged as to throw in or out of gear when desired, and the receiver may readily be made of sufficient capacity to serve for starting the engine from 20 to 30 times. In the handling of engines of smaller size where the auxiliary compressed-air receiver is not fitted, recent practice shows various improvements in detail, such as the provision of a lever for reducing the compression when turning by hand, retaining just sufficient to insure ignition. Manipulation of this lever to reduce the compression serves also to retard the spark, so that there can be no "kick back" or danger to the operator when "cranking" by hand.

Muffling. Great improvements have been made in recent years in connection with the decrease of the sound occasioned by the exhaust. In principle the muffler operates by splitting up the individual puffs, in part mechanically and in part by the acoustic influence of an intermediate chamber, in such manner as to dissipate and absorb the sound energy of the exhaust and reduce the succession of sharp exhaust puffs into a more nearly constant and gentle discharge. It is not practicable to realize the full beneficial effect of the muffler except by some increase in the back pressure against which the engine exhausts, and in cases where the maximum power is an absolute necessity the muffler should be cut out and the noise accepted as the price to be paid for the additional power. To permit of this the muffler should be so installed that it can be readily cut in or out, and in both cases the exhaust leads should be direct and free in order to reduce the back pressure to a minimum.

Economy. The matter of economy is little thought of in connection with the typical engines used in small runabout boats, but with those of larger size—from 20 horsepower upward for example—the question of economy will affect in a serious manner both the expense of operation and the radius of action. It is for these reasons among others, as already noted, that the four-cycle engine, with its superior economy, is preferred for such cases. The formula very commonly quoted with reference to the economy of internal combustion motors using gasoline is "one pint per horsepower hour." This is better than two-cycle engines can be depended on to give, and small four-cycle engines will not give any such figures except with care and under the best conditions. One pint per horsepower hour means good conditions with the four-cycle engine of moderate to large size. At the same time, with special care, this result may be slightly bettered, while on the other hand but slight departure from the conditions for best operation will serve to carry the consumption above this figure. Economy with an internal combustion engine depends on the following chief conditions:

(1) The proper proportion of air to gasoline vapor: *i.e.*, the proper quality of the charge.

(2) A proper degree of compression.

(3) Prompt ignition and complete combustion.

(4) The highest practicable degree of expansion on the power stroke.

(5) Only such an amount of cooling by the water jacket as may serve to keep the surfaces of cylinder and piston in good working condition.

(6) Valve ports of sufficient area to insure prompt and full admission and release.

With these various conditions fulfilled in good degree, and with engines of fair to large size, a consumption of one pint per horsepower per hour may be counted on with confidence, but with neglect of the proper precautions, and in small sizes especially, the consumption may rise to twice this amount, or more.

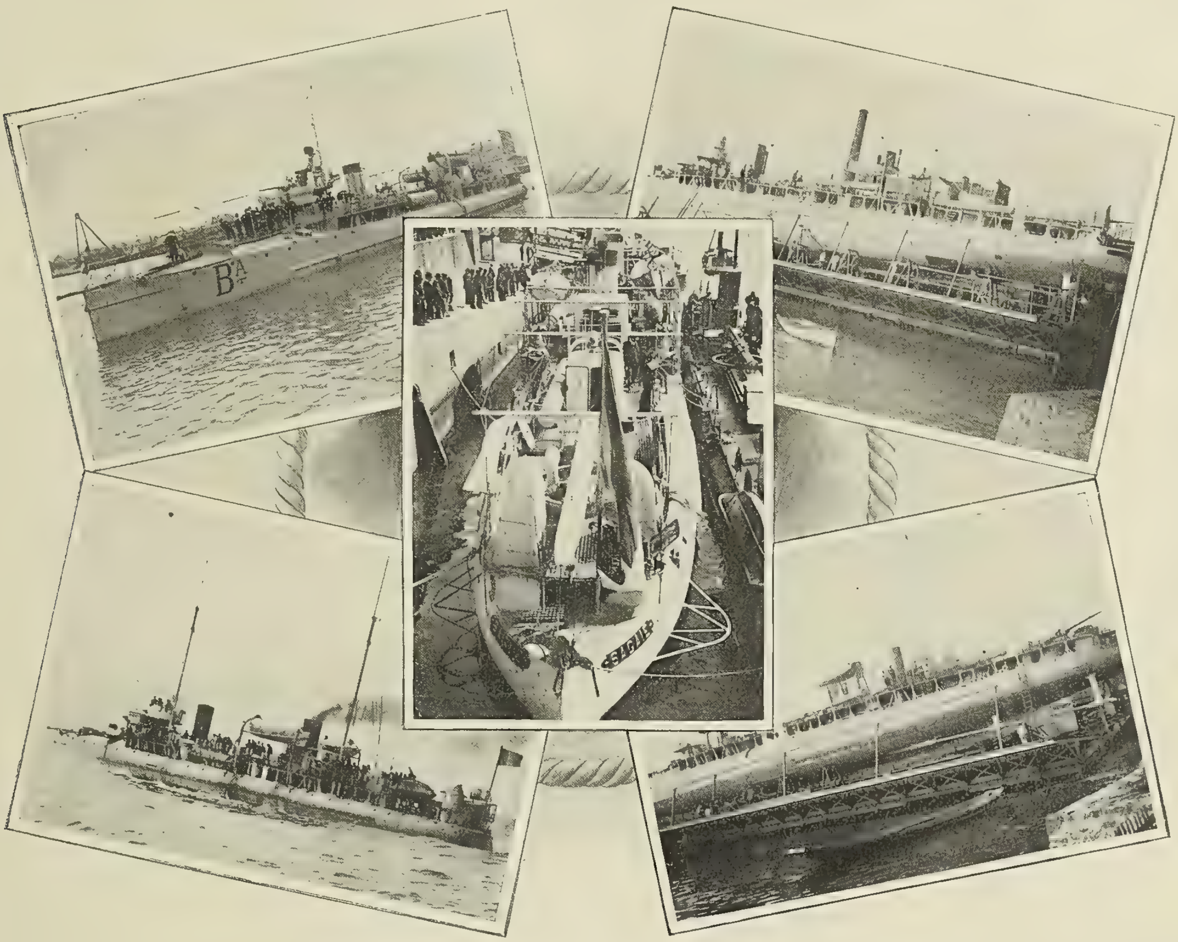
(To be continued.)

French Destroyers.

The destroyers ordered under the last building programme of the French navy are now nearly all in service, and a comparison can readily be made as between the several types. The three types of boat constructed have the same general appearance, being all from the designs of Normand, of Havre. The hulls are so formed that instead of cutting through the water by main force they are expected to glide over the water in much the same manner as some of the extreme types of recent motor boats.

NEW TYPES OF FRENCH DESTROYERS.

Class type	*Durandal.*	*Pique.*	*Mousquel.*
Number	Four.	Nine.	Twenty-three.
Displacement	301 tons.	319 tons.	303 tons.
Length, L. W. L	180′ 6″	185′ 8″	184′ 8″
Beam, extreme	19′ 6″	19′ 7″	19′ 8″
Draught	9′ 10″	9′ 11″	9′ 4″
Boilers	4 Normand.	4 Normand.	2 Normand.
Engines	2 triple exp.	2 triple exp.	2 triple exp.
Horsepower	4,800	5,700	6,300 to 7,200
Designed speed	26 knots	26 knots.	28 knots.
Trial speed	27 to 27.5	25.5 to 26	30.79
Normal coal supply	38 tons.	34 tons.	27 tons.
Steaming radius:			
At full speed	217 miles.	194 miles.	217 miles.
At 10 knots	2,300 "	2,055 "	2,300 "
Coal consumption at 14 knots speed	......	......	910 pounds per hour.
Corresponding radius	......	......	900 miles.



NEW FRENCH DESTROYERS OF SECOND AND THIRD TYPES.

The destroyers form a very small target, as the freeboard is low and the open-work deck above the main part of the hull will explode shells without their striking the main deck. The Normand boilers are quite remarkable in the fact that although the entire power is 7,200 horsepower there are only two boilers in each boat, which means that each boiler must develop 3,600 horsepower. The maximum speed corresponding with the power mentioned is 31 knots, but it is found that the hull vibrates considerably at speeds above 23 knots.

Among the defects of this type may be mentioned the fact that the extremely shallow draft due to the form of hull above mentioned precludes the possibility of attaining high speed in all weather and it is also found that the stability is not so great as might be desired, on account of the high position of the nine-pounder gun mounted on the conning tower. The remainder of the battery consists of six one-pounder guns and two 18-inch torpedo tubes. The crew consists of four officers and 40 or 50 men.

J. PELTIER.

Professor P. F. Walker, who has been at the head of the Department of Mechanical Engineering in the University of Maine, Orono, Me., has been called by the University of Kansas, Lawrence, Kan., to take charge of the Department of Mechanical Engineering.

Charles Green, who has had some twenty years of experience covering nearly every important shipyard in the United States, has just opened a consulting office at 2115 Durand avenue, Berkeley, Cal.

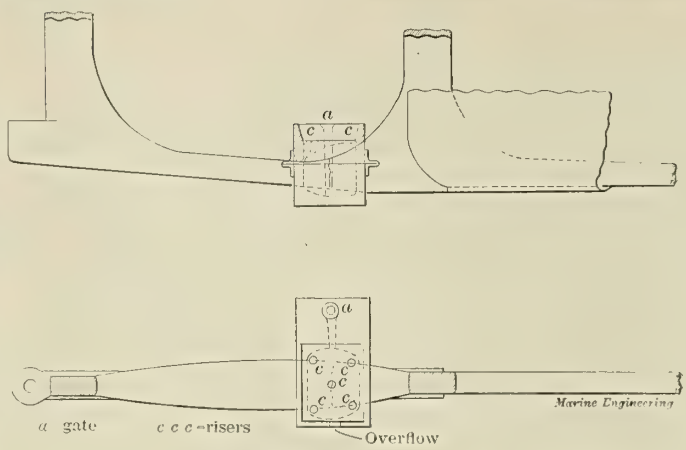
Welding Break in Stern Frame of Steamship Apache.

The vessel was placed in dry dock about 1 P. M., July 28, 1905, and the water was entirely pumped out at 2.15 P. M. Propeller wheel was removed and shaft drawn into the hull, for the purpose of examining same for the benefit of underwriters. It was not necessary to remove the wheel and shaft to perform the work. The shoe, or skeg, as it will be hereafter called, had been broken and patched; two large plates had been placed, one on each side, about 2½ inches thick each, and about 16 inches wide. Top and bottom plates had also been put on, forming a box, as it were, around the break. These were removed at 3.20 P. M. The break was found to be about 18½ inches from the after side of what is termed the "stern post" (not the rudder post).

A mold and mold box had been previously prepared, allowances were made in the clay mold so that it could be fitted tight to the skeg. It was decided to have an aperture of clearance in the break for the metal to flow through, and as it was impossible to spread the broken parts, a series of holes, 1 inch in diameter, was drilled vertically through the skeg, nine in number, following the line of the crack. The section to be welded measured 6¾ inches vertically, by 11 inches horizontally. Air drills were started at these holes as soon as the patches were removed. Arrangements were made to have the mold and mold box put into a furnace at about 6.30 P. M., to be left there until the following morning. It will be understood that the mold had been one week in preparation and drying, and the final heating was now to be applied. The skeg was then heated to a red heat and the mold box taken from the furnace and put in place. A foundation was built under the mold box, and a riser of brick, forming a base with a wall about one brick wide and 12 inches high, was formed around the mold box, forming a basin, as it were, into which moist sand was poured. The joints were well looted and sand well packed up around the looting, so that the entire mold was thoroughly protected in case of any leaks. As the section to be welded was very broad it was thought best to have it well ventilated, and five risers were prepared, the riser box being very shallow, with a spout for the slag to run off, and a trough in the sand leading to a pit which was formed at one side, over which was a cover of sheet iron to protect the operators from the heat.

PREPARING THE MOLD FOR THE THERMIT WELD.

A small open furnace had been prepared and placed on top of the mold, in which a charcoal fire was burnt. Air from the compressed air supply on the dock was utilized for draught, and hot gas was forced down through the gate and up through the riser. While this was in progress, the crucible was put in place, the ordinary tripod being used; and 475 pounds of thermit placed in it, together with 100 pounds of steel punchings previously heated, and 10 pounds of manganese mixed into the thermit. The mixture of the thermit, punchings and manganese was performed by pouring in each consecutively, each being well stirred as it was placed in the crucible.



SKETCH SHOWING ARRANGEMENT USED.

Owing to the pre-heating, the final reaction was retarded until 4.35 P. M., when the thermit was ignited and the reaction took place. The slag, though precautions had been taken to contain it within walls and canals, overflowed its bounds in the gate, causing some little difficulty for a few minutes; this portion of the slag was covered with sand. Thermit was then used in feeding to the risers and gate, feeding in gradually, maintaining continuous reaction for several minutes to relieve the mold of gases which might form in the body of the weld. This proved to be very effective, as much gas was seen to come from the mold through the risers and gate during the feeding process. This was continued until 50 pounds had been consumed.

THE WELD COMPLETED, BUT NOT TRIMMED.

The mold was allowed to remain in place over night, gradually cooling, and was then annealed by surrounding the weld with a box, into which charcoal fire was prepared. This fire was continued about five or six hours, allowing the weld to gradually cool. In the morning when the mold boxes were removed, the gate and risers were trimmed off, and the grain of the metal appeared to be of exceptionally good quality, and cut very freely with the pneumatic tools. The shaft and propeller wheel were then put in place, and the vessel was ready for docking by 10 A. M. of the third day.

In this work a No. 10 crucible was used, with the ordinary sheet iron cover with an asbestos lining. After the reaction in the crucible the cover, etc., were in good condition, and may be used for several reactions more. The sheet iron stand which formed part of the crucible was partially melted off, but this does not affect the strength of the crucible, as another stand can be easily applied.

THE NEW AUTO-BOAT NINA UNDER WAY.

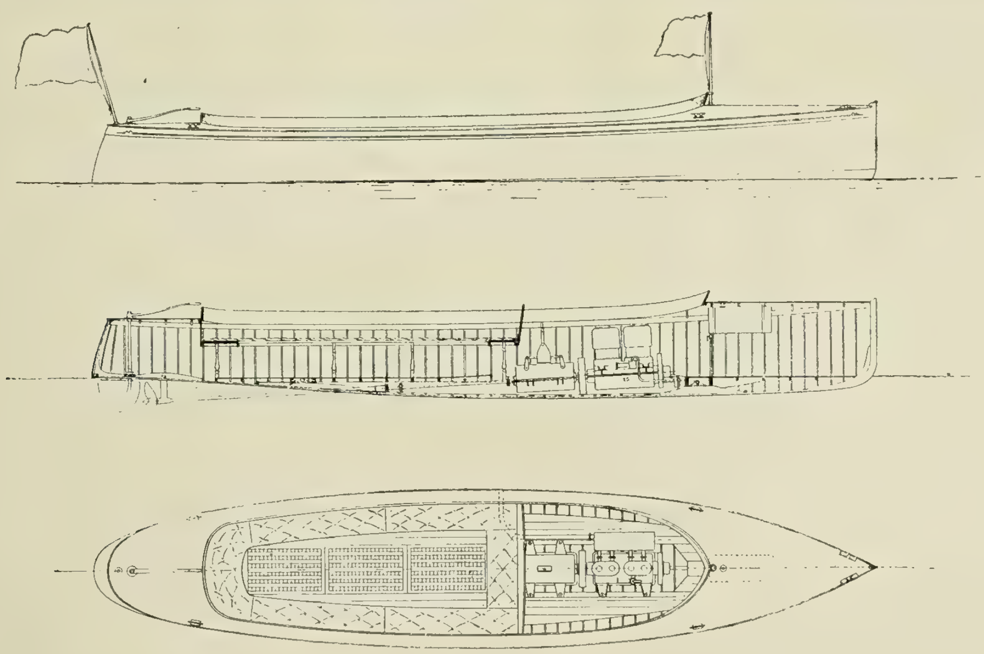
An Interesting Pleasure and Racing Launch.

BY L. RAMAKERS.

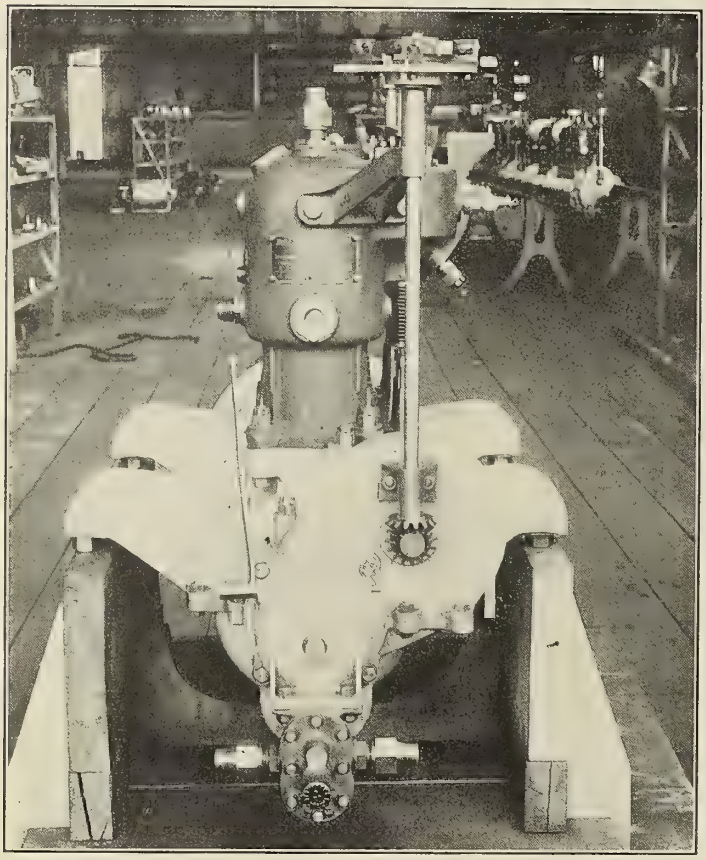
The illustrations we give herewith refer to the English 25-foot fast pleasure or racing launch *Nina,* which, although of very recent make, won last season, during which she took place in several races, the Cowes Cup, the Godfrey Baring Cup (Shanklin), Shanklin Town Cup, and a silver fruit dish at Southsea.

General description.—Beam, 5 feet 1½ inch; draft, 17½ inches. The seams being secured by Saunders sewn or copper stitched system, no rivets or nails are used. The launch is fitted with a four-cylinder 4 by 4½-inch Thornycroft petrol motor developing 20 B.H.P. at 900 revolutions. The engine is provided with high tension magnet and high tension coil and battery ignition. Reversing is effected by means of a lubricated multiple disc friction clutch and epicyclic gear. A large reserve petrol tank is provided under the after seat and supplies petrol to a small tank situated under the turtleback forward of the engine by means of a Wilcox semi-rotary hand pump. Feed from the small tank to the carbureter is by gravity. A speed of 13 miles can be maintained for a ten-hours' run; when in racing trim she can reach about 17 miles. The seating capacity is sixteen persons, if necessary. For racing purposes, the engine and the helmsman are protected by a collapsible canvas hood having a talc window fitted in the front. The whole of the control mechanism can be easily operated by one man, without altering his position.

Motor.—The engine is a vertical water-cooled enclosed motor, designed to run at a normal speed of 900 revolutions per minute, and capable of acceleration to 1,400 revolutions per minute. The cylinders are cast in pairs, each pair forming with its water jacket a single casting. The water jacketing extends about halfway down from the firing end and has been carefully designed to avoid "pockets," and to allow a free and natural run for the cooling water, which is circulated around the cylinders and radiator by a gear-driven positive-action enclosed pump operated from the crank shaft. Each piston is fitted with four cast-iron spring rings, thus obviating any chance of gas leaking past the piston. The



PROFILES AND DECK PLAN OF AUTO-BOAT NINA.



END VIEW OF THE ENGINE.

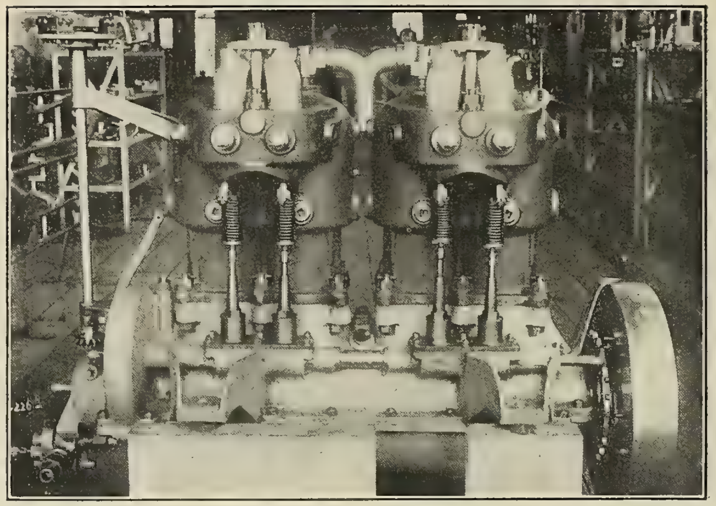
connecting rods are of double tee section, stamped in steel, with gudgeon and big-end bearings, phosphor-bronze bushed, the big ends being adjustable, the big-end cap brasses are slightly less in width than the bottom brasses, thus saving a little weight and ensuring better crank-pin lubrication.

The crank shaft is of special steel, in one piece, with a central bearing between pairs of cylinders; the cranks of each pair of cylinders are at 180 degrees; those of the one pair being at 180 degrees with those of the other pair, thus giving the engine a perfect balance; the end bearings are each 2¾ inches long by 1⅜ inches diameter, thus ensuring ample bearing surface. The forward end of the crank shaft carries the gear wheel operating the water circulating pump above mentioned.

The starting is effected by means of a ratchet wheel and pawl bolted to the flywheel, and a starting handle, secured by a bracket, in an accessible position immediately above the flywheel; the ratchet wheel and starting handle are connected by an endless chain. The crank chamber is of aluminum and is completely enclosed, the internal lubrication being by the "splash" method.

The half-speed shaft is actuated by the crank shaft, and bears the cams for operating the exhaust valves. Between the cams and the ends of the valve stems hard steel rollers are inserted to diminish friction and wear. The exhaust-valve stem guides are very long and of bronze, giving steady support and preventing loss of oil.

The centrifugal governor is carried on the crank shaft and is wholly enclosed in an aluminum casting; it is connected to the throttle valve in the induction pipe and regulates the speed of the motor by throttling the mixture. The water circulating pump is driven by reduction gear from the crank shaft. All gearing is enclosed and lubricated from the crank case. The induction valves are of the spring operated type, and are placed above the exhaust valves on the same side of cylinders, thus tending to keep the latter valves cool. Both induction and exhaust valves are so arranged as to be readily accessible for examination, cleaning, and re-grinding, when necessary.



SIDE VIEW OF THE ENGINE.

UNITED STATES DREDGE BARNARD.

BY ROBERT S. RILEY.

The United States dredge *Barnard* externally is what the Mississippi River men call a good-looking steamboat. Internally she has many more triple-expansion, surface-condensing engines, and other complications, than any river boat ever possessed before. She was designed to help open and maintain the proposed new channel for navigation through the delta of the Mississippi River. South Pass is proving too narrow and tortuous for modern ships, so the government has undertaken to open up the wider channel which Southwest Pass will afford as soon as the bar at the mouth can be cut through.

The *Barnard* was built by the New York Shipbuilding Company, of Camden, N. J., in 1904. Her appearance, finish, and satisfactory performance reflect just credit to her builders.

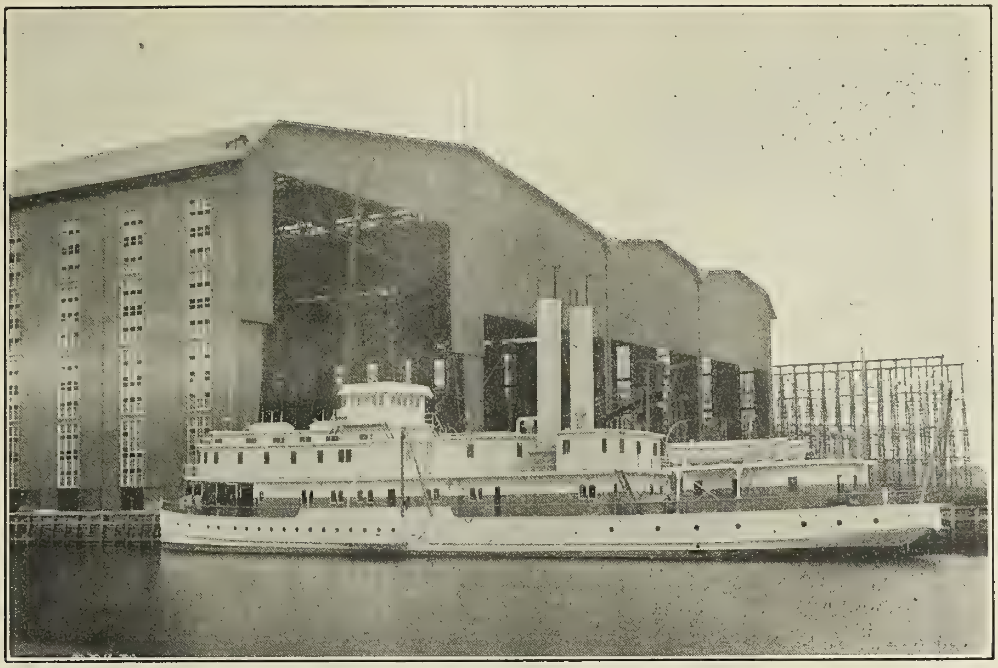
Her principal dimensions are:

Length between perpendiculars	198 feet 6 inches
Length over all	210 feet
Beam	38 feet
Depth molded	14 feet 6 inches
Draft	8 feet

These dimensions, together with the deck plans and illustrations, show that the *Barnard* is a hydraulic dredge of rather an unusual type. She is, in fact, somewhat of an experiment in regard to the arrangement of her dredging machinery, and its combination with the propelling machinery. She combines many features of the Mississippi River hydraulic dredge with those of a light-draft, twin-screw river steamboat. But unlike the up-river dredges, her suction pipe and handling gear are self-contained. This gives her sea-going qualities not possessed by them, and with her speed of 10 knots, makes her quite a handy ship for working over a bar in a moderate sea. She shows less dredging gear on the outside than the sea-going hopper dredges with suction pipes hanging outside. The *Barnard*, however, is not intended for outside use; her work will be mainly in Southwest Pass and the bar at the mouth of the jetties. But she has amply proven her seagoing stability by a trip under her own steam to New Orleans from the New York Shipbuilding Company's yard on the Delaware.

The hull, being shallow, has only the main deck. Heavy iron stanchions support the superstructure, which is entirely of wood. The main feature of the hull is the suction well. It begins 28 feet from the bow, is 7 feet wide, and runs for 60 feet along the midship line. The details of framing, etc., are shown in the cross section of the ship. There are in all seven transverse bulkheads.

The fore peak is utilized as a paint locker. Next comes the chain locker, extending across the ship. From the after bulkhead



THE DREDGE BARNARD AT YARD OF NEW YORK SHIPBUILDING COMPANY.

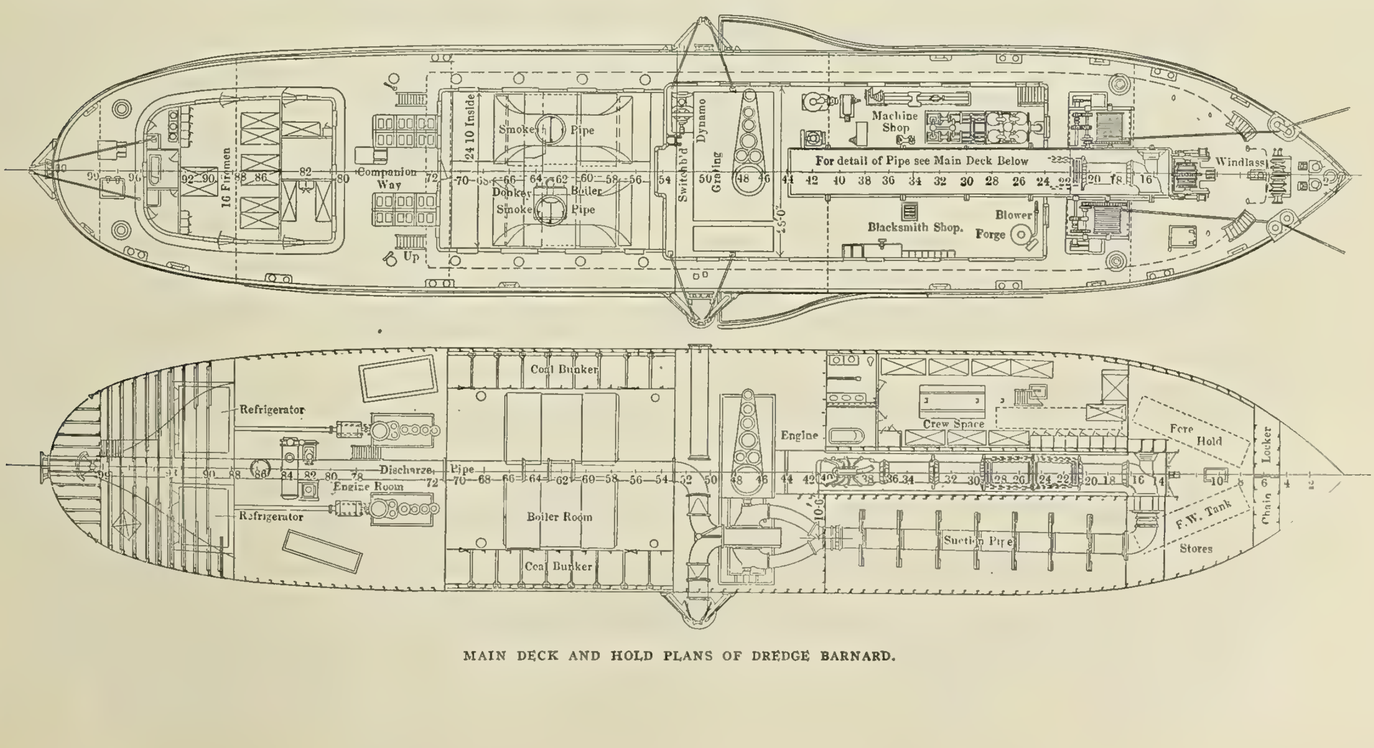
of this to the beginning of the suction well is a store room, beneath the floor of which are stowed two cylindrical fresh-water tanks 40 inches in diameter and 20 feet long.

Abreast of the suction well there are two compartments. The one on the port side is fitted up for the quarters of the deck-hands. It has cots for sixteen men. There are also large individual lockers with wash room, bath room, etc. In the center is a table and seats which may all be raised up to the deck above, leaving a clear space for the men. Below the floor of the living quarters is another fresh-water tank of the same dimensions as those under the store room forward of the well. The compartment on the starboard side of the suction well is used for storage of engineers' supplies. The main suction pipe passes through here on its way to the pump.

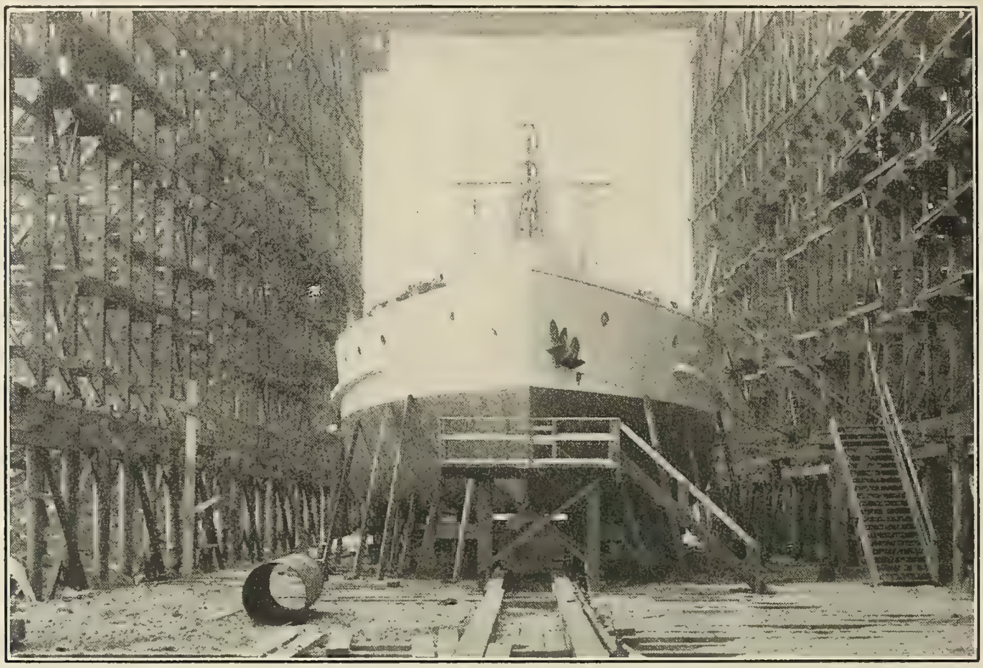
Aft of the suction well is the pumping engine room, extending clear across the ship for 18 feet fore-and-aft. Then comes the boiler room with two double-ended boilers side by side, and bunkers abreast of these. Aft of this comes the propelling engine room for 34 feet, full width. The after end of the ship is occupied by a tank of 22.3 tons capacity, and above it are the cold-storage rooms and stewards' supplies.

The main deck forward is clear of any house for 48 feet, though the superstructure deck is carried out over it to within 14 feet of the bow, where two curved stairways lead up from the main deck. The anchor windlass is located forward. The suction hoisting engine is just forward of the well opening; and the large hauling winches are abreast of the well on either side, just forward of the house. Two capstan barrels also appear on this deck outboard of the hauling winches. Their engines are located beneath the deck, and are accessible from the compartments alongside of the suction well.

The house on the main deck begins 48 feet from the bow, and extends for 96 feet aft, leaving a gangway 5 feet wide along the rail on either side. The forward end of this house contains the

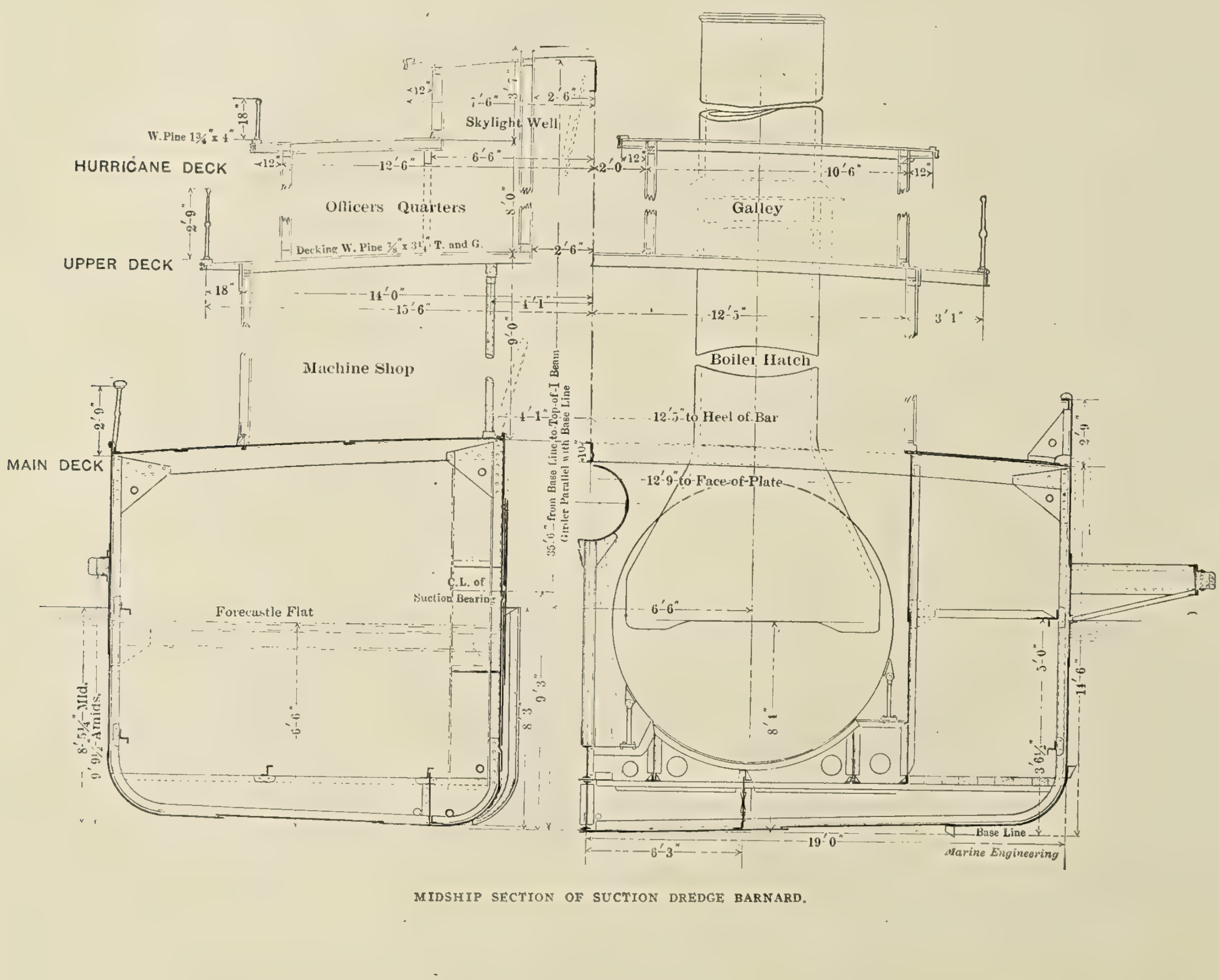


MAIN DECK AND HOLD PLANS OF DREDGE BARNARD.



BOW VIEW OF BARNARD JUST BEFORE LAUNCHING.

machine shop and jet pump on the port side of the well, and the blacksmith and carpenter shops on the starboard side. Then comes the working platform of the pumping-engine room, with the generating set and steering engine. A bulkhead then divides this part of the house from the space over the main boilers. The auxiliary boiler is situated over the starboard main boiler, and a small auxiliary bunker over the port boiler. The house on this deck stops at the after end of the boiler room. There are three large double sliding doors along each side of this house, two at each side of the machine shop, and one each side of the boiler space. These doors, together with numerous large windows, make this deck as comfortable as possible in a tropical climate.



MIDSHIP SECTION OF SUCTION DREDGE BARNARD.

The overhang of the superstructure deck also serves as efficient shelter from sun and rain. Aft of this main house the deck is cut by a companionway and skylights over each propelling engine. Here also two stairways lead up to the after end of the superstructure deck.

The after house on the main deck has a well-equipped laundry on its forward side. The main room is fitted up for the accommodation of sixteen firemen. They have comfortable iron cots, individual lockers, and their own wash room, bath rooms, etc., in the after part of the house. The space in the main deck aft of this is used for handling lines. There are two capstan barrels with engines below the deck; a companionway leads to space below.

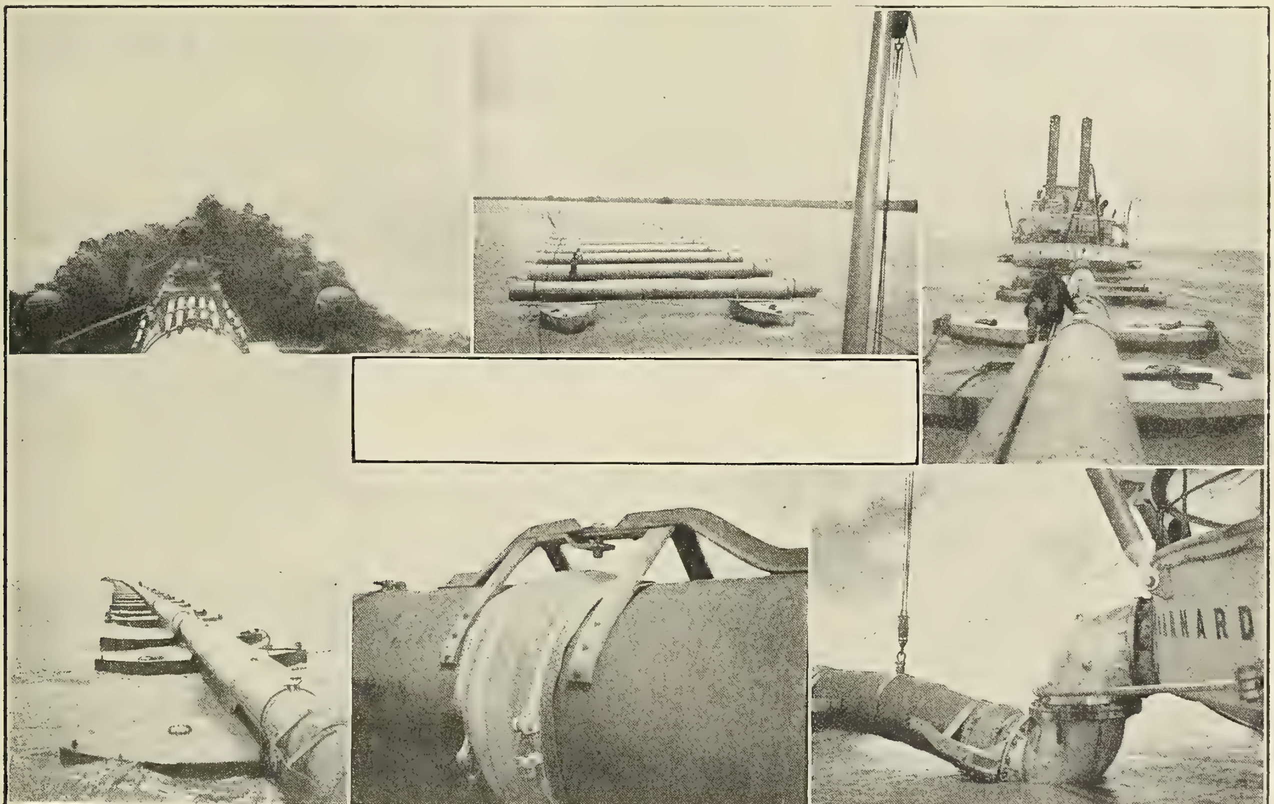
On the superstructure deck the forward end is occupied by the cabins of the officers. The suction well has a clear overhead space carried right up through the superstructure deck to the skylights above the cabin deck. This space is necessary for the suction hoisting tackles, which are suspended from an I-beam over the well, 27 feet above the water-line. Thus the cabins are built on either side of this opening, extending the length of the suction well. The cabins are all very large and airy. Accommodation is provided for twenty officers. The rooms at the after end are fitted up as lavatories, bath rooms, linen lockers, and stewards' store room.

Aft of this house the superstructure deck is cut by the skylight over the pumping engine. Aft of this again are two smaller houses abreast, the officers' mess room and stores on the starboard side, with the galley, pantry, and refrigerator on the port side. The galley deserves special mention for its size, excellent location, and complete equipment.

Aft of these two houses the smokestacks pass up through the deck. The last house on the superstructure deck is the crew's mess room. It has a room in the starboard end for cooks. There is no structure above the firemen's house on the main deck. It is used as a boat deck, and the four boats which form the equipment of the dredge are stowed there.

The pilot house is built over the after end of the main house on the superstructure deck. It is a handsome airy room 12 by 12 feet, and stands 40 feet above the water-line, commanding the whole situation in true Mississippi River style. From the pilot house communicating systems run to all the working platforms, so that the propelling engines, pumping machinery, suction operating gear, and hauling winches may all be worked to co-operate as desired.

It will be noticed that one of the features of the *Barnard* is the attention paid to the comfort of the crew. Not only are the quarters airy and comfortable for the warm weather of the Gulf, but the sanitary conditions are well provided for. Every window and door in the living quarters is provided with shutters and mosquito netting. This latter feature is of course especially important in malarial districts. All the cabins and living quarters are supplied with running water, both hot and cold. The lavatories all have porcelain fittings, and the crew as well as the officers have porcelain bath tubs. The laundry adds greatly to the comfort of all on board, especially when stationed in isolated places. A complete steam-heating system is also installed for winter service up the river.

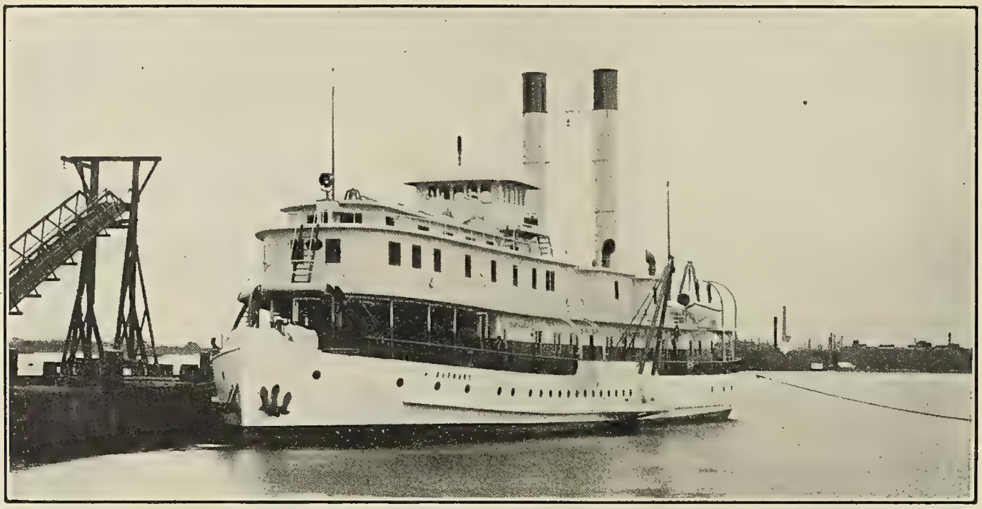


DISCHARGE AT END OF PONTOON LINE. — PONTOON LINE CONNECTED FOR TOWING. — VIEW OF DREDGE FROM PONTOON LINE.
VIEW OF PONTOON LINE FROM DREDGE. — CONNECTION IN PONTOON LINE. — SWIVELING ELBOW CONNECTION TO DREDGE.

A more detailed description of the machinery follows:

STEAM PLANT.

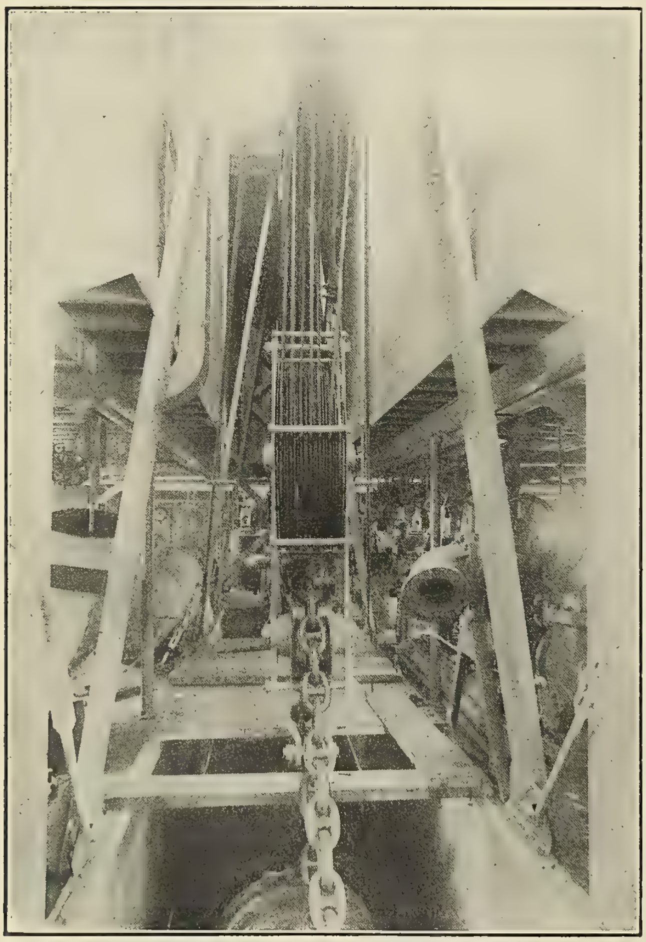
There are two main boilers of the Scotch double-ended marine type. They are 11 feet in diameter and 18 feet 2½ inches long, built for 170 pounds pressure, in conformance with the rules of the United States Supervising Inspectors. Each boiler has four corrugated furnaces, 43 inches inside diameter, opening into a common combustion chamber of unusually large dimensions. The total heating surface is 4,686 square feet, and the total grate surface 172 square feet, giving a ratio of 28.3 to 1. These boilers



U. S. DREDGE BARNARD ON THE DELAWARE RIVER.

have given great satisfaction under rather severe conditions; when dredging and cruising simultaneously they burn over 20 pounds of coal per square foot of grate surface per hour, and this under natural draft.

There are two main stacks, 52 inches in diameter, and 60 feet in height above the grate bars. The bunkers are situated along the sides of the ship abreast of the boiler room; they have a capacity of 120 tons. The auxiliary boiler is located on the main deck, over the starboard main boiler. It is of the Scotch, dry-combustion-chamber type, 5 feet in diameter and 5 feet long.

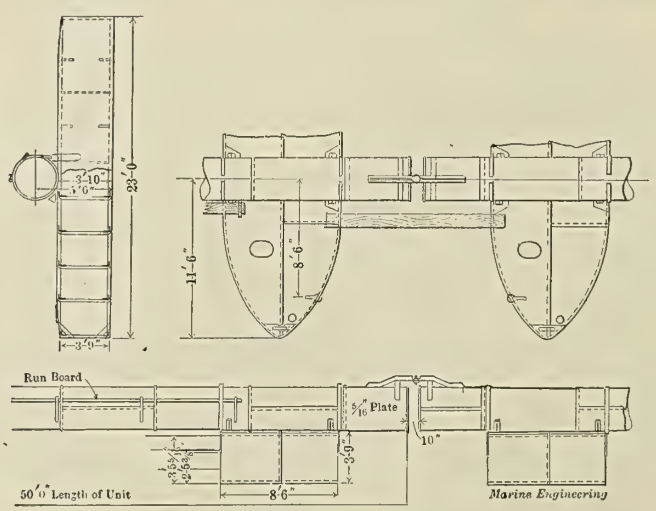


SUCTION WELL LOOKING AFT, SHOWING TACKLE.

DREDGING MACHINERY.

The dredging pump and engine are direct connected, with axes athwartship. The pump room is located just abaft the suction well, and extends clear across the ship. Beginning at the port side come the L.P., I.P., and H.P. cylinders respectively, with the pump over on the starboard side of the ship. The dredging pump has a suction pipe 38 inches in diameter, which divides and enters at both sides of the casing. The discharge pipes are 36 inches in diameter, and the discharge leaves the pump at the top. The casing is in three sections bolted together. It shows a rectangular cross section through the axis; that is, the side discs of the casing are flat, and the outer sweep is a plain curve, terminating in a rectangular discharge pipe 32 by 32 inches.

The pump casing is fitted throughout with renewable liners, this being necessary owing to the gritty material handled. There are heavy cast-iron throat rings in the suction connections, which are also renewable. In the sides of the casing opposite the outer edge of the runner are recesses into which wearing rings are fitted. These wearing rings have chilled faces adjacent to corresponding rings on the runner. They are adjustable by means of bronze setting screws, so that as the clearance wears greater it may be reduced, and the pump thus kept always at its highest efficiency. The pump runner is of the enclosed type, 90 inches in diameter, made of cast steel, with wearing strips of chilled cast iron on its outer edges, corresponding to the adjustable wearing



PONTOON PIPE-LINE CONNECTIONS.

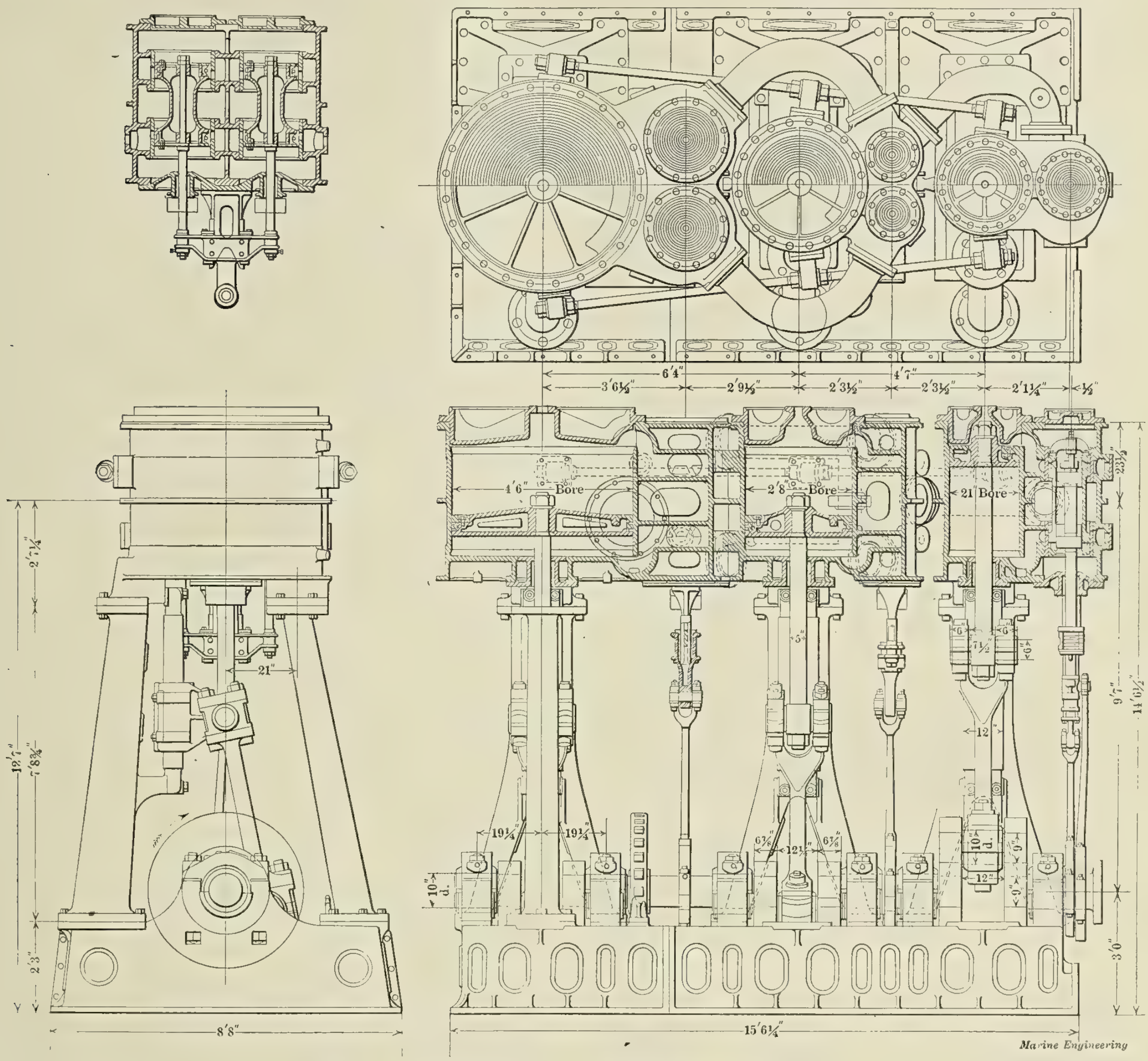
rings described in the casing. The runner is 32 inches wide across its face.

The pump shaft is of steel, 12 inches in diameter at the runner, and 10 inches in diameter at the ends. It runs out through the suction elbows through stuffing boxes bushed with bronze. The lower sections of the pump casings form an integral part of the bed plate, to which the engine bed plate is bolted. The whole structure, engine and pump, rests upon a substantial foundation, which comprises four keelsons in addition to the center keelson. There is almost no vibration apparent in the pump room.

The main dredging pump is driven by a vertical, inverted, made by turning the valve stem. The whole arrangement is very neat and compact and has given great satisfaction.

The speed of the engine is controlled by a Pickering governor, acting directly on the throttle valve. It varies from 110 to 130 revolutions per minute, depending on the conditions of pumping. The power developed is approximately 1,000 indicated horsepower.

All working parts of the engine are of ample dimensions, with a complete water and oil service suited for continuous running. The journal service is supplied by a Blake horizontal duplex pump, 6 and 4 by 6 inches. In this engine room is also a sanitary and general service Blake horizontal duplex pump, 5¼ and 4¾ by 5



DESIGN OF TRIPLE-EXPANSION ENGINE DRIVING CENTRIFUGAL PUMP.

triple-expansion engine; cylinders 21, 32, and 54 inches, with a stroke of 26 inches. This engine is of the modern marine type, with cast-iron back housings, and open cast-iron columns in front. The valves are all of the piston type, with two each for the I.P. and L.P. gears. The high-pressure valve is an interesting arrangement of the Meyer cut-off in a piston valve. It consists of one piston-valve within another. The valve stems are also concentric with each other, the cut-off valve stem being a sleeve fitted with stuffing box through which the main valve stem passes. But the valve stems are not concentric with the valves. This eccentricity of the valve stems is arranged in order to hold the sections of the cut-off valve against turning while adjustment is inches. The pumping engine has its own condenser and equipment of auxiliaries. The condenser has 2,400 square feet of cooling surface. The air pump is a Davidson valveless simplex, 9 and 18 by 10 inches. The circulating pump is the New York Shipbuilding Company's standard 10-inch size.

There are two different types of suction heads supplied for different kinds of material to be worked. The drag head has a straight cutting edge, 6 feet 6 inches wide, which scrapes up the material as it is dragged along by the motion of the dredge. The body is of cast steel and cast iron, with the cutting edge of steel plate. Bars are placed across the opening to prevent large solid bodies, such as logs of wood, etc., entering to damage the pump.

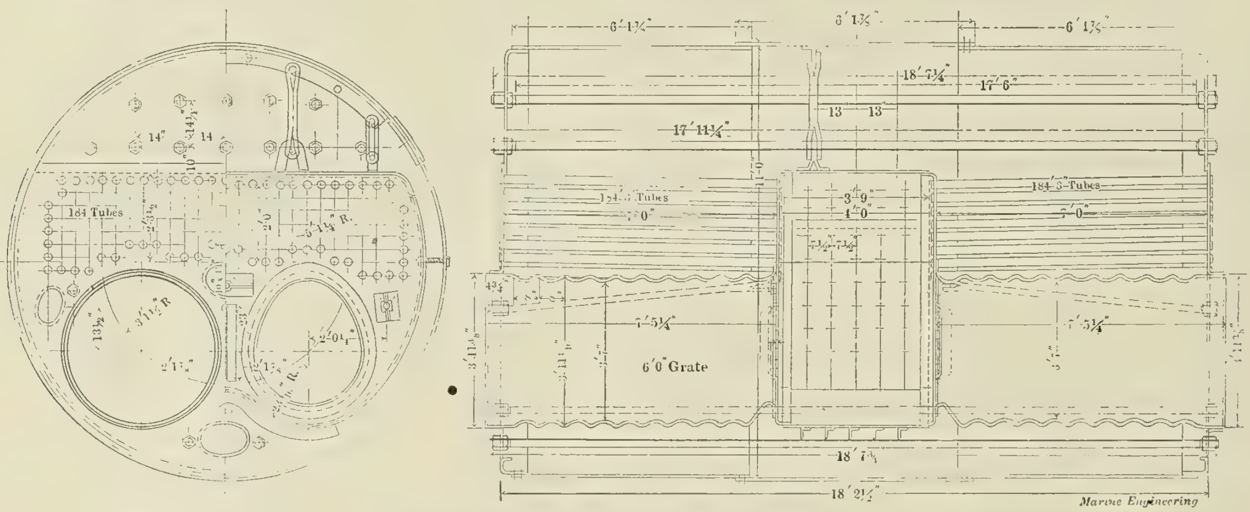
Near the cutting edge is a series of small holes for admitting water with the material to be dredged. There is also a large relief valve which may be opened to admit water, in the event of the mouth being choked entirely. This type of head is particularly suited to a sandy bottom.

The other head which may be used on the suction pipe is called the jet or suction sinking head. It is similar to an inverted scoop and is built up of steel plates with 8- by 1-inch screen bars across the opening.

From a header on top radiate eight pipes 2 inches in diameter. These are arranged around the lower edges of the head in such a way that water may be driven through them under pressure, and thus loosen up the material to be dredged. This device is very effective in sticky mud and blue clay. When dragged lightly over the bottom this head sucks mud from a path 12 feet or more in width. To supply water for these jet pipes a large compound duplex-plunger pump is located in the port side of the suction well at its forward end. It has steam cylinders 10 and 18 inches, water cylinder 14 inches, with a stroke of 16 inches, and can supply water up to 100 pounds pressure. This water is carried in an 8-inch hose along the main suction pipe to the header mentioned on top of the sinking head.

From the trunnion elbow at the forward end of the well the 38-inch suction pipe turns aft through another elbow and runs through the compartment on the starboard side of the well. On entering the pumping-engine room it couples onto a "Y" pipe which admits to both sides of the pump so as to counterbalance the thrust. The discharge, taken from the top of the pump casing, enters a switching valve, which is operated by a shaft extending up to the starting platform of the pumping engine. This valve can be locked in three positions, to discharge to starboard, to port, or equally on both sides. The starboard discharge goes directly overboard through a short connection. The port discharge also leads overboard through a pipe running across the ship; but by the removal of a section of this pipe an elbow may be inserted to connect with the astern discharge. The discharge from the port side of the switching valve then leads aft from the center of the pump room, between the boilers, through the propelling-engine room and after compartment, out through the stern of the ship. The discharge piping is all 36 inches in diameter.

On each bow of the dredge is a powerful hauling drum containing 2,000 feet of 1-inch wire cable. These drums are operated by double vertical engines, 8 by 8 inches, made by the American Ship Windlass Company. By means of these cables, attached to



LAYOUT OF ONE OF THE MAIN BOILERS ON BARNARD.

From the suction head the suction pipe leads to a trunnion elbow at the forward end of the well. The elbow passes through the starboard bulkhead of the well through the stuffing box in which it swivels. Opposite the stuffing box a projection on the elbow extends across the well to a bearing in the port bulkhead. These two bearings support the forward end of the suction pipe. The pipe is about 50 feet long and when up in a horizontal position it is clear of the water and folds up in the suction well somewhat like the blade of a jackknife in its handle.

The suction pipe is operated by means of two wire-rope tackles, one supporting it in the middle and the other at the suction head. The leads of these tackles run to the suction hoisting engine just forward of the well. They are arranged so that the pipe is kept nearly straight as it is raised and lowered about the trunnion elbow. In the middle of the pipe is a section of 38-inch rubber hose 15 feet long. This gives flexibility to the pipe to allow for lateral movements of the dredge, or uneven working of the hoisting tackles. The suction head can be lowered to dredge to a depth of 40 feet. The hoisting tackles are fixed to a 15-inch I-beam which runs along amidships over the well 20 feet above the main deck. It is supported by four "A" frames built over the suction well. The engines of the suction hoisting winch are 9 by 12 inches, and capable of handling the pipe instantaneously, even though half full of sand. Quick work is often necessary to prevent the suction head being caught under the ship in the event of a side current striking the dredge.

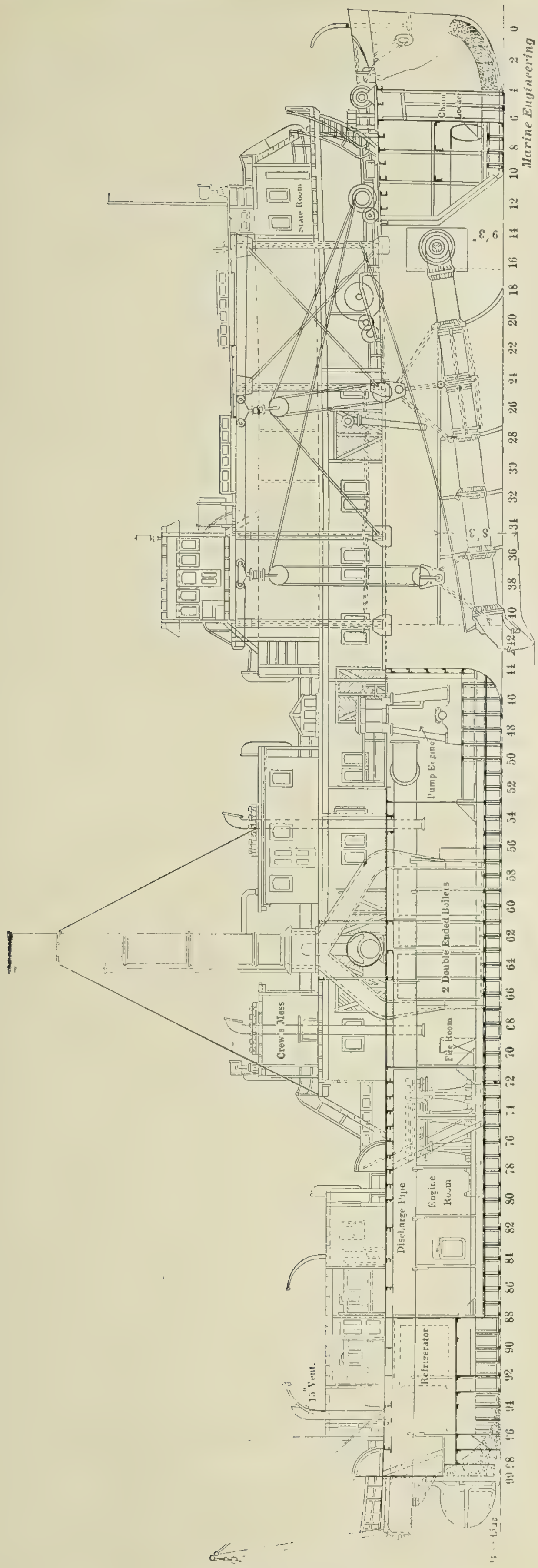
4,000-pound anchors, the dredge can be held in position or hauled ahead as desired.

The dredge has a complete installation of propelling machinery capable of giving her a speed of 10 knots. She has twin screws, with triple-expansion engines 12, 18, and 30 inches by 18 inches stroke. At 200 revolutions per minute they develop 900 indicated horsepower. The engines are of the regular marine type, with open front columns and piston valves throughout.

The propelling-engine room is unusually large and roomy. It extends for 34 feet near the after end of the ship, and occupies the entire width. There are no shaft alleys as the stern tubes start at the after engine-room bulkheads. The propeller shafts connect to the short section of line shaft by means of a Lovekin patent loose coupling. In the propelling-engine room is ample room for all auxiliaries, including evaporating plant and a two-ton refrigerating plant with its ice box.

The propelling-engine condenser has 1,400 square feet of cooling surface, with the usual outfit of auxiliaries, Davidson air pump, and 8-inch New York Shipbuilding Company's centrifugal circulating pump. The feed and filter tank is unusually large, to take care of any dirty water that might work in from the Mississippi. It is 12 feet long, 3 feet wide, 2 feet 6 inches deep. The filtering is done very effectually with rice straw.

There are three Blake vertical duplex feed pumps, 7½ and 5 by 6 inches, all located at the forward bulkhead of the engine room. A separate Blake horizontal duplex pump, 6 and 4 by 6 inches, is used to feed the auxiliary boiler.



INBOARD PROFILE OF THE SUCTION DREDGE BARNARD.

DECK MACHINERY.

The steam-steering engine is located on the main deck over the pump room. It is a Williamson, 5 by 5½ inches. The rudder has 50 square feet area. The rudder quadrant had to be kept below the discharge pipe which runs amidships out through the stern. The anchor windlass is of the pump brake type, built by the American Ship Windlass Company. There are four single barrel-steam capstans, one at each corner of the ship. The engines, 5 by 8 inches, are placed below the main deck. They were also built by the American Ship Windlass Company.

ELECTRIC-LIGHTING PLANT.

The generating set is located on the main deck over the forward or pumping-engine room. It consists of a 9 by 6-inch Sturtevant vertical engine direct connected to a 15-kilowatt generator, 350 revolutions per minute. The switchboard was designed and built by the New York Shipbuilding Company. Besides 130 16-candle-power incandescent lights, in various parts of the ship, there are two 1,200-candle-power arc lights, and two 18-inch searchlight projectors. These searchlights have controlling gear for operation from various parts of the ship.

EVAPORATING AND DISTILLING PLANT.

The evaporator is located in the after end of the propelling-engine room. It is of the Reilly make, 2,500-gallons capacity per 24 hours, with a distiller of 500-gallons capacity for drinking water. The plant is supplied with the necessary feed, circulating, and fresh-water pumps. There are three cylindrical storage tanks for the fresh water distilled, two located in the forward peak and one in the hold on the port side of the suction well, with a total capacity of 5,400 gallons.

REFRIGERATING PLANT.

The ice machine is located in the port side of the propelling-engine room. It is built by the Remington Machine Company, of Wilmington, Del. The two ammonia compressing cylinders are single acting, 5 inches diameter, 9 inches stroke. The steam cylinder is 8 inches diameter by 8 inches stroke; all cylinders are vertical. The ammonia condenser is a vertical cylinder standing on a separate base. The ice-making tank has eighteen ice cans, holding 100 pounds each. A Deane horizontal duplex pump, 4½ and 3¾ by 4 inches, circulates the brine.

The cold-storage rooms are located aft of the engine-room bulkhead, and have a capacity of about 1,000 cubic feet. The acceptance test of the plant required that it should be run in 6- or 8-hour watches and with 6- or 8-hour stops, and make 600 pounds of ice per day; and at the same time maintain a temperature of 34 to 36 degrees in the cooling chambers. The entire refrigerating plant has ample capacity to fulfil these requirements under the severe conditions found in the Gulf of Mexico.

MACHINE SHOP.

In order to keep the equipment of the *Barnard* in repair, without recourse to machine shops up the river, she has a very complete machine shop of her own. It occupies the main deck on the port side of the suction well forward of the pumping-engine room.

The machines consist of:

One 24-inch screw-cutting lathe, with 16-foot bed, made by the New Haven Manufacturing Company, of New Haven, Conn.; one 25-inch drill press, made by the Fairbanks Company, of New York; one 18-inch crank shaper, made by the Ohio Machine Tool Company; one combined bolt and pipe threading machine, by the Jancke Manufacturing Company, of Erie, Pa.; one emery grinder with 12-inch wheels, made by the Diamond Machine Company, of Providence, R. I.

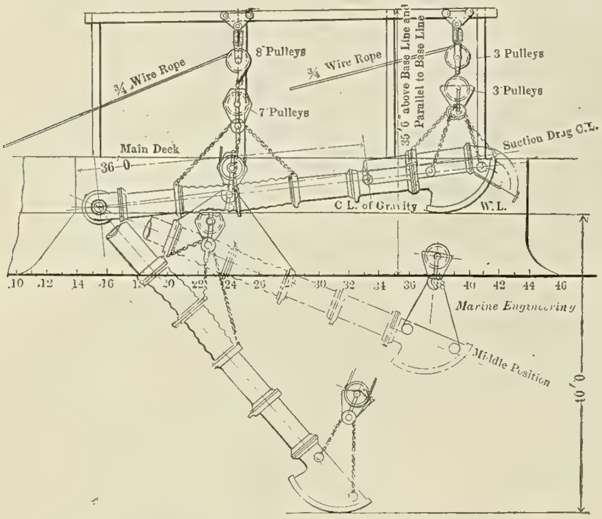
The machine-shop shafting is driven by a 7 by 9-inch vertical single engine, made by the New York Safety Power Company, of New York. All the machines have a very complete equipment of tools. There are also four hand vises and a well-selected set of hand tools, such as stocks, dies, reamers, files, etc.

The blacksmith and carpenter shops occupy the deck at the starboard side of the suction well. The blacksmith shop has a 42-inch circular forge with power-driven blower, made by the B. F. Sturtevant Company, of Boston, Mass.

PONTOON LINE.

The pontoon line consists of eighteen sections each 50 feet in length and 36 inches inside diameter. Each section is supported by two pontoons, one near each end. Each pontoon is an elliptical shaped float made of ¼-inch plate. They are 23 feet long, 8 feet 6 inches wide, 3 feet 9 inches deep, pointed at each end with arcs of 11 feet 3 inches radius. The pontoons are set athwart the pipe and secured by suitable saddles and bands.

The sections of the pontoon pipe are held together by heavy brackets riveted to the ends. These brackets connect the sections by means of heavy bronze pins and allow the sections to swing about each other in a horizontal plane. The end section of the pontoon pipe has a baffle plate 5 feet wide from the end of the pipe. This baffle plate is controlled by a windlass on the last pontoon, and may thus be set and held at any angle. This deflection of the discharge from the pipe reacts on the water and swings the end of the line in any direction desired. It must always be used unless the last section is secured; for if not, the reaction of the discharge plunging into the water would cause the pipe line to coil up on itself.



SHOWING FLEXIBILITY OF SUCTION PIPE.

In order to make a continuous conduit for the material in the pipes, the spaces between the sections were connected by canvas sleeves, as shown in the illustration. These sleeves were made of 16-ply canvas firmly riveted and sewn together. The ends are slipped over the half-round finish on the pipe ends and then clamped. This arrangement is much cheaper than rubber and equally effective. It is the idea of Major Patrick, of the U. S. Engineer Corps.

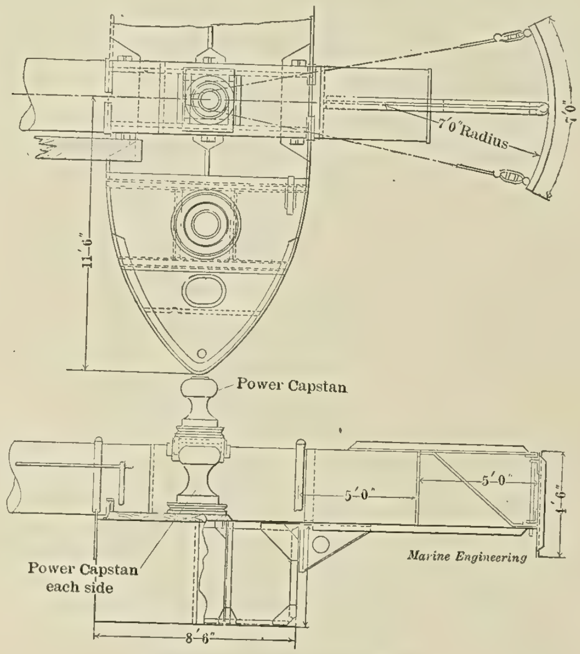
The pontoon line is connected to the dredge by means of a swivelling elbow, as shown. This elbow may be connected at the astern discharge, or at either of the side discharges. Shear legs over each discharge facilitate the handling of the heavy cast-steel elbows. The sponsons forward of the side discharges are for the protection of the discharge elbows when connected at the side.

OPERATION.

When dredging through the pontoon line the dredge is anchored and dropped back on the hauling cables. It can then be hauled ahead or stopped as desired. The jet-sinking head is used when the dredge is on the cables, and the method of operation is to let the suction head sink down about 18 feet in the mud, then hoist up and haul ahead to a new position. The suction pipe is then lowered again to its work. This method does not involve stopping the pumping engine, for the suction head is not raised out of the water. The result is a series of holes along the lead of the cables. A hole 12 feet wide, 20 feet long, and 18 feet deep, is dug by this method in 3½ minutes, including the time used in hauling ahead, etc., ready for another cut.

The pontoons being placed athwart the pipe they offer great resistance to towing when the pipe is coupled up for dredging. In fact, with the currents found in the Mississippi it is almost impossible for the dredge to make any headway against the stream with her own propellers. For towing purposes, therefore, the sections of the pontoon line are disconnected and brought up broadside to the current so that the pontoons may be towed end on. This arrangement of the line is shown in the illustration.

When working in a strong current over a bar near deep water, the *Barnard* dispenses with the pontoon line. She then cruises with her propelling engines and simply discharges at each side. With light mud this method is very effective, for the current carries the material out over the bar into the Gulf before it has time to settle. Even with heavy sand the material is moved seaward a considerable distance before it settles. Either type of suction head may be used while cruising. The jet-sinking head is very effective in the mud, while the drag head is more effective in sand. This method of stirring up the bars at the mouth of the Mississippi has been used for many years. On a wide, shallow bar, where a pontoon line is out of the question owing to rough water, etc., the dredging must be done in this manner till sufficient draft is obtained for a hopper dredge. The present bar at the mouth of the Southwest Pass has 10 feet of water over the crest, and the first problem for the *Barnard* is to obtain a channel 20 feet or more in depth. The hopper dredges can then take their loads and carry them out to sea. Later on the *Barnard* will build up the jetties and levees along the banks by discharging through the pontoon line. A special type of elevated discharge is being built by which the material can be thrown well out on the bank.



DISCHARGE END OF PIPE LINE.

The dredge is also provided with an elevated side discharge by means of which she may pump directly into barges alongside. But the great capacity of the pump—over 400 cubic yards of water and sand per minute—makes it a difficult matter to supply barges rapidly enough.

R. S. Cooper has recently been appointed manager of the New York office of the Independent Pneumatic Tool Company, of Chicago, with headquarters at 170 Broadway, New York.

Edward P. Field, of the firm of Sadler, Perkins & Field, is recovering from an operation for appendicitis.

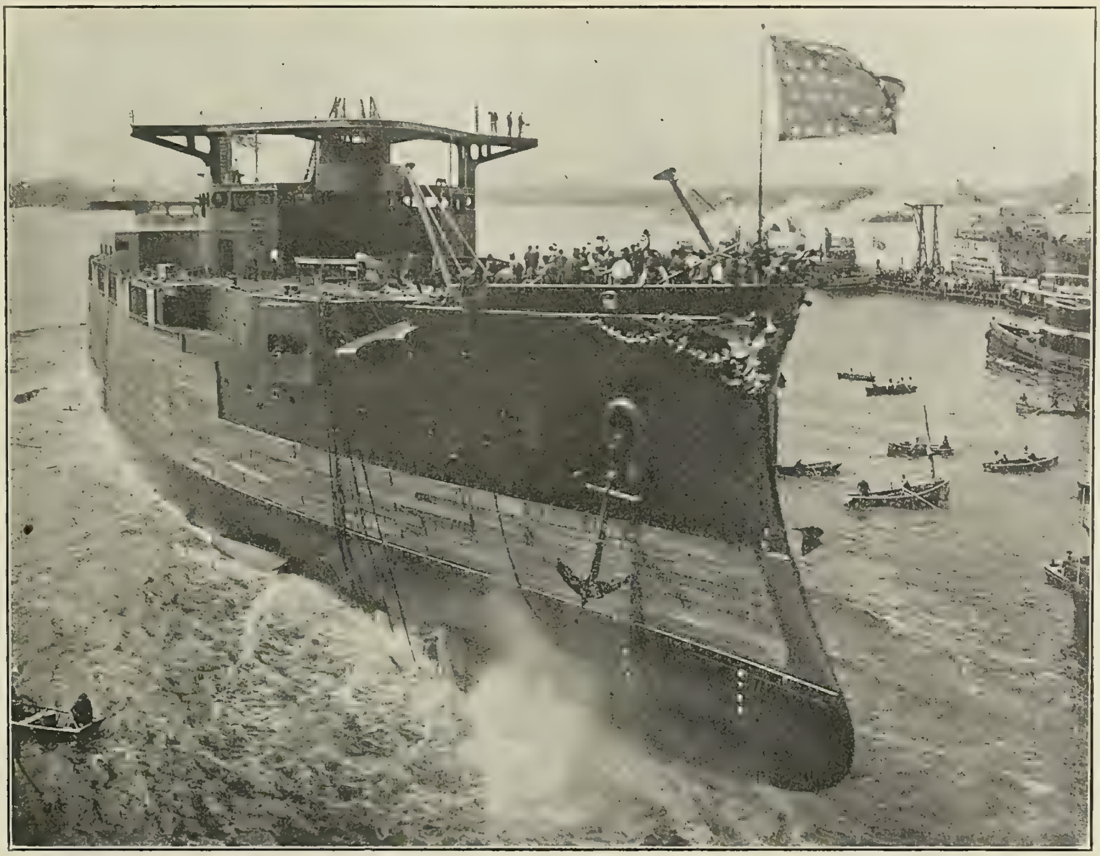
LAUNCHING OF TWO BATTLESHIPS.

On August 12 the United States battleship *Kansas*, one of the largest and most powerful yet laid down, was launched by Miss Anna Hoch, daughter of the governor of Kansas, from the yards of the New York Shipbuilding Company, Camden, N. J. The ceremony was performed with water, instead of the usual champagne.

On August 31, the new battleship *Vermont*, a sister of the *Kansas*, was successfully launched by Miss Jennie C. Bell, daughter of the governor of Vermont, at the yards of the Fore River Shipbuilding Company, Quincy, Mass.

The following description of the designs of the *Vermont* is taken from the official circular published for the information of bidders. It applies equally well to the *Kansas*.

The battery will be mounted as follows: The 12-inch guns in pairs in two electrically-controlled, balanced, elliptical turrets on the center line, one forward and one aft, each with an arc of fire of about 270 degrees. The 8-inch guns in pairs in four electrically controlled, balanced, elliptical turrets, two on each beam, at each end of the superstructure. The 7-inch guns in broadside on pedestal mounts on the gun deck behind 7-inch armor, each gun being isolated by splinter bulkheads of nickel steel from 1½ to 2 inches thick; forward and after guns arranged to fire right ahead and right astern respectively; other 7-inch guns to have the usual broadside train. The guns of the secondary battery in commanding positions, having a large arc of unobstructed fire, and protected wherever practicable. All the 7-inch guns are so arranged that their muzzles train inside the line of the side armor, thus



THE LAUNCHING OF UNITED STATES BATTLESHIP KANSAS.

General dimensions and features of the vessel are as follows:

Length of load water-line	450 feet
Breadth, extreme, at load water-line	76$\frac{10}{12}$ feet
Displacement on trial, not more than	16,000 tons
Mean draft to bottom of keel at trial displacement	24½ feet
Gross draft, full load, about	26¾ feet
Total bunker capacity, coal, about	2,000 tons
Coal carried on trial	900 tons
Feed water carried on trial	66 tons
Trial speed at sea for four hours	18 knots

The hull is to be of steel throughout, fitted with docking and bilge keels.

Armament.—Main battery, four 12-inch breech-loading rifles; eight 8-inch breech-loading rifles; twelve 7-inch breech-loading rifles.

Secondary battery, twenty 3-inch, 14-pounder, rapid-fire guns; twelve 3-pounder semi-automatic guns; eight 1-pounder automatic guns; two 3-inch field pieces; two machine guns, caliber .30; six automatic guns, caliber .30.

leaving a clear and unobstructed side when it is desired to go alongside a pier or vessel. Arrangement will be made whereby the 3-inch guns on the main deck can be quickly and conveniently dismounted, housed, and secured.

Armor and Similar Protection.—The hull is protected at the water-line by a complete belt of armor 9 feet 3 inches wide, having a maximum thickness of 11 inches for about 200 feet amidships. Forward and aft of this the maximum thickness is 9 inches within the limits of magazines, from which points the thickness is gradually decreased to 4 inches at the stem and stern.

The lower casemate armor extends to the limits of the magazine spaces and reaches from the top of the water-line belt to the lower edge of the 7-inch gun ports on the main deck, and is 6 inches in thickness, the athwartship bulkheads at the ends of this casemate also being 6 inches thick. The casemate armor around the 7-inch guns on the gun deck is 7 inches thick, and the splinter bulkheads are from 1½ to 2 inches thick. The projection of 3-inch guns is nickel steel 2 inches thick. The upper casemate athwartship armor extending from the shell plating to the 12-inch barbettes is to be 7 inches thick throughout.

The 12-inch barbettes extend from the protective deck to about 4 feet above the main deck, and consist of 10 inches of armor in front and 7½ inches in the rear above the gun deck. Between the gun deck and protective deck there will be a uniform thickness of 6 inches. The barbettes will not have any special framing, the connection of the armor to the decks being sufficient. The 12-inch turrets will have a front plate 12 inches thick, rear plates 8 inches thick, and top plates 2½ inches thick.

The 8-inch barbettes will be 6 inches thick in front and 4 inches thick in rear, with the upper tube 3¾ inches thick and the lower tube 3 inches thick. The 8-inch turret front plate will be 6½ inches thick, the rear plate 6 inches thick, and the top plates 2 inches thick.

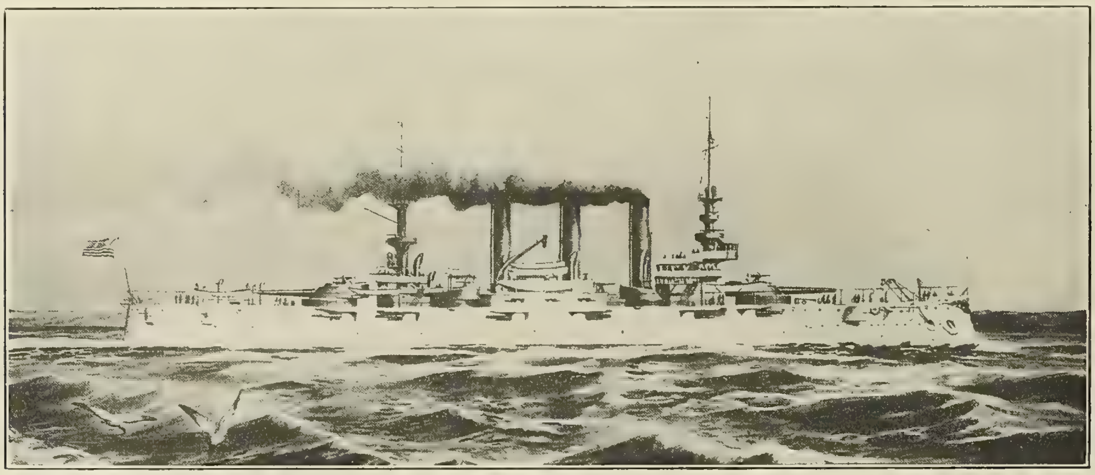
The conning tower and shield will each be 9 inches, and the signal tower 6 inches thick. An armor tube 36 inches in diameter will extend from the base of the conning tower to the protective deck, and will be 6 inches thick throughout.

Teak backing of a minimum thickness of 3 inches will be fitted behind all side, athwartship, and 12-inch armor; 2 inches of backing to be fitted behind the 8-inch turret armor; other armor will be fitted without backing.

ammunition rooms or ammunition passages to the deck on which it is required, or as near that as possible. These hoists will be driven at constant speed by an electric motor and will be arranged to deliver seven pieces per hoist per minute.

The number of hoists will be as follows: twelve for 7-inch, fourteen for 3-inch, 3-pounder and 1-pounder combined, and sufficient whip hoists to the tops. To supply the 7-inch hoists, four horizontal ammunition conveyors, operated by electric motors, will be fitted in ammunition passages for the transfer of ammunition from the handling rooms to the base of the hoists. The turret guns have regular turret ammunition hoists, operated by electric power, these hoists leading directly from the handling rooms or the ammunition passages to the turrets. For transporting 12-inch, 8-inch, and 7-inch ammunition, trolleys and tracks will be fitted in handling rooms, passages, and shell rooms.

Propelling Machinery.—The engines will be of the vertical, twin-screw, four-cylinder, triple-expansion type, of a combined I.H.P. of 16,500. The steam pressure will be 250 pounds. The stroke will be 4 feet. The ratio of high-pressure to low-pressure cylinder will be about 1 to 7, the diameters being respectively 32½, 53, 61, and 61 inches, giving the required I.H.P. at about 120 revolutions per minute. Each engine will be located in a separate watertight compartment.



GENERAL APPEARANCE OF VERMONT TYPE OF BATTLESHIP.

Protective Deck.—There is a complete protective deck extending from stem to stern, the deck being flat amidships, but sloped at the sides throughout, and sloped at each end. It will be built up of 20-pound plating throughout, with nickel steel of 40 pounds on the flat and of 100 pounds on the slopes.

The following nickel steel protection is also to be fitted: Hatch covers and gratings in the protective deck; splinter bulkheads on gun deck; sponsons and wing plates for two forward 3-inch guns on gun deck; bullet shields between wing plates for 3-inch guns and 7-inch guns; side protection and wing plates for 3-inch guns on main deck; turret shelf plates; conning-tower base plates; 7-inch gun port sill plates; 80-pound protection on ammunition-hoist trunks not otherwise protected by armor, and 80-pound protection on coaling trunks on slope of protective deck to the height of berth deck amidships.

Cofferdams about 30 inches thick and extending from protective deck level will be worked from end to end of the vessel, these cofferdams being extended above the berth deck, forward and abaft the transverse armor, to a height of about 36 inches. The cofferdams will be packed with cellulose or other approved water-excluding material.

Ammunition.—The magazines and shell rooms are so arranged that about one-half the total supply of ammunition will be carried at each end of the ship. Magazine bulkheads adjacent to heated compartments, such as fire rooms, engine rooms, and dynamo rooms, are arranged with air spaces. The ammunition for 7-inch and smaller guns will be conveyed by hoists directly from the

There will be twelve boilers of the Babcock and Wilcox type, placed in six watertight compartments. They will have about 1,100 square feet of grate and 46,750 square feet of heating surface, and must be able to furnish steam for the main engines and all necessary auxiliary machinery and other steam machinery throughout the ship with an average air pressure in the ash pits of not more than 1 inch of water.

There will be three funnels, each 100 feet high above the base line.

The following auxiliary steam machinery of approved make and design, in addition to that pertaining to the main engines and dependencies, is to be supplied: steering engine; windlass engine; ash-hoist engine for each fire room; forced-draft blowers; ice plant with a cooling effect of 3 tons of ice per twenty-four hours; evaporating plant to consist of not less than four units, having a total capacity of 16,500 gallons of fresh water per day; a distilling apparatus capable of condensing at least 10,000 gallons of water per day. The vessel to be heated by steam throughout.

The weight of all machinery and tools, stores, and spare parts will be about 1,500 tons.

The vessel will be lighted throughout by electricity. The electric plant will consist of eight 100-kilowatt steam-driven generating sets, all to be of 125-volts pressure at the terminals, disposed in two separate and independent dynamo rooms. There will be fitted all the usual means of interior communication, such as telephones, voice pipes, call bells, buzzers, gongs and annunciators, engine and steering telegraphs, revolution and rudder indicators, heeling indicators, automatic fire alarm, warning signals, alarm signals, etc. The total weight of equipment outfit, complete, will not exceed 355.28 tons.

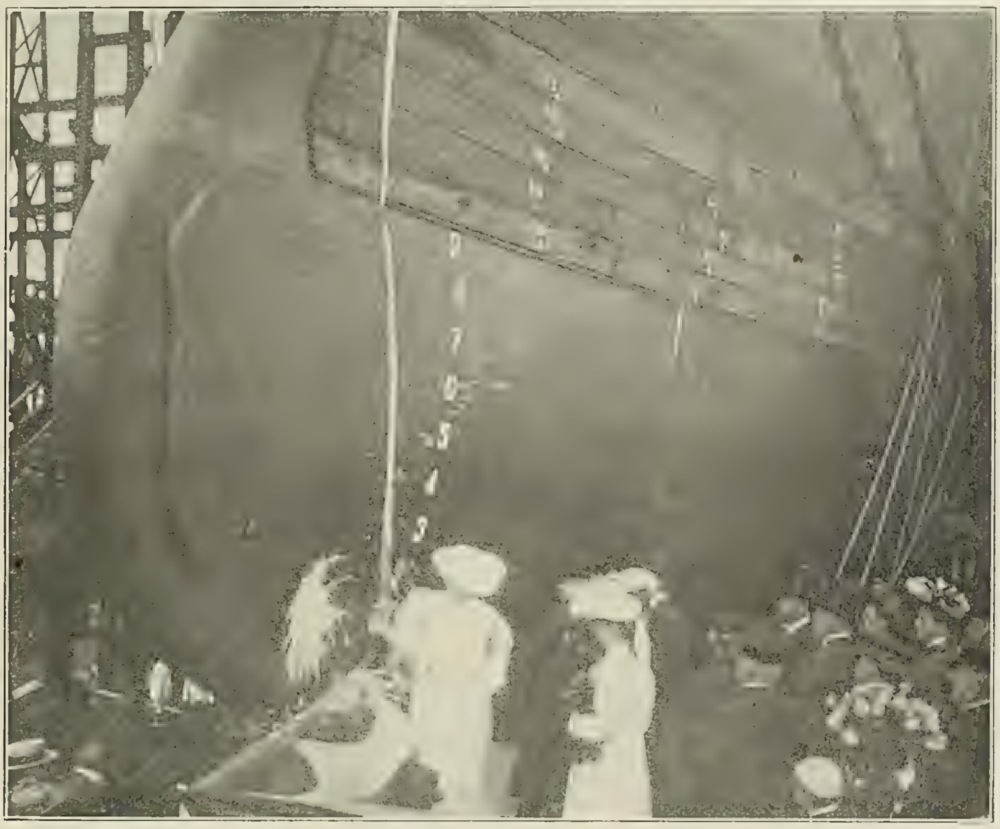
With the exception of the auxiliaries above mentioned to be operated by steam, all power on board of the vessel will be electric, as, for instance, boat cranes, deck winches, turret-turning motors, ventilation-blower motors, etc. All main compartments of the ship below the gun deck, except the coal bunkers, are to be provided with forced ventilation, there being no less than thirty-three blowers, with a combined capacity of 104,000 cubic feet per minute. Special attention has been given to spaces subject to habitually high temperature, such as engine rooms, fire rooms, and dynamo rooms. The ventilation system will be designed to cut the minimum number of watertight bulkheads. All blowers, except forced-draft blowers, are to be electrically operated.

The coal bunkers are to be arranged with satisfactory reference to the rapid and efficient supply of coal to the fire rooms, and have a maximum capacity of about 2,200 tons. There are to be provided for coaling not less than six winches, twelve booms, and all necessary fixed chutes, scuttles, hatches, and other openings. There will be two billboards and four hawse pipes; all hawse pipes to be so designed that stockless anchors may be stowed in them. There will be four heavy anchors, two of the navy type and two of the stockless type.

The following boats will be carried, adequate provision being made for their convenient stowage and handling by two electrically-operated boat cranes, eight pairs of boat davits, adjustable boat chocks, and all necessary fittings provided for this purpose: One 50-foot steam cutter; two 36-foot steam cutters; one 36-foot steam launch; three 33-foot launches; five 30-foot cutters; two 30-foot whaleboats; one 30-foot gig whaleboat; one 30-foot barge; two 20-foot dingeys; one 16-foot dingey; one 14-foot dingey; and two life-rafts.

The vessel is designed as a flagship, and the arrangement of quarters provides ample accommodations for the following complement: a flag officer; a chief of staff; nineteen ward-room officers; ten junior officers; ten warrant officers; and not less than 761 men, including 60 marines.

There is a lower bridge both forward and aft, and a flying bridge forward, according to the latest practice. On the flying bridge is fitted a screen of bronze for the protection of the men at the wheel, and there is also a bronze chart house forward. There are steel masts forward and aft, the foremast having an upper and lower top, the main mast a lower top only. Masts are arranged for wireless telegraphy. There is one signal yard on each mast, also a searchlight platform forward and aft, with a crow's nest on the foremast.



BREAKING THE BOTTLE ON THE BOW OF THE VERMONT.

A summary of the weights to be carried on trial is as follows:

	TONS.
Guns, mounts, magazine equipments, etc.	944.94
Ammunition, two-thirds full supply	393.97
Steam engineering, complete, with water in boilers, condensers, piping, etc., and stores, etc., not to exceed	1,500.
Reserve fresh water for steaming purposes	66.
Coal, normal supply	900.
Boats and outfits	51.27
Masts and spars	30.08
Equipment, complete, including anchors, chains, electric plant, etc., and two-thirds equipment stores	355.28
Miscellaneous stores and water, two-thirds full supply	81.32
Provisions, clothing and small stores, two-thirds full supply	146.84
Officers, crew, and effects	103.32
Total protection, including armor, armor backing, armor bolts, cellulose, and splinter bulkheads	3,992.

This leaves, as the weight of the hull, fittings, and protective deck, about 7,434 tons.

The percentage of completion of the *Kansas* is about 62, and of the *Vermont* about 65.

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Engineers in the Navy.

The report of the Board of Inquiry into the *Bennington* disaster has been submitted to the Navy Department and has, in the main, been approved. The department has, however, gone further than its recommendations by ordering not only the court martial of Ensign Wade, who was in charge of the machinery of the *Bennington* at the time of the accident, but also that of Commander Young, who had charge of the ship itself. The latter officer has declared his expectation of being completely vindicated by virtue of the fact that he had, on numerous occasions, reported the boilers of the *Bennington* to be absolutely unsafe, and that, as his warnings were unheeded, responsibility for a tragedy which cost the Navy more than three times as many lives as were lost in action in the war with Spain rests primarily upon the department.

It seems to us that the only possible culpability of Commander Young might lie in the possibility that certain disagreeable rumors regarding the effect of San Diego rum upon the men immediately in charge of the boilers might have some foundation in fact, and have indicated a laxity in discipline, not, perhaps, without precedent in the Navy, but certainly without the possibility of justification. It is almost inconceivable, as one of our contemporaries remarks, that men in a sober condition, who were in possession of any knowledge whatever upon the subject of boilers, should have gone on firing under the boiler when the lack of pressure in the gauge could not but have indicated that something was wrong. It is also very much of a mystery how the air cock, not being closed, failed to sound a warning.

Whatever the true explanation may be, it is quite certain that those immediately responsible, as well as those ultimately responsible for the condition of affairs which made possible the explosion, are entirely beyond the reach of any human court martial; and that we must look for an improvement in matters to an entire rehabilitation.

This is the finding of the court:

"That the *Bennington* arrived in the harbor of San Diego, Cal., on July 19, 1905, from Honolulu, Hawaii, being *en route* to Panama to relieve the *Princeton;* that the ship was in an excellent state of discipline and in a good and efficient condition, with the exception of her boilers, which were in fair condition and efficient considering their age (about fourteen years) and the use to which they had been subjected.

"That on July 20, orders were received to proceed at once to Port Harford, Cal., and convoy the *Wyoming* to the navy yard at Mare Island, Cal.; that at this time the ship was coaling and her boilers and engines were being overhauled preparatory to her voyage to Panama; that upon the reception of telegraphic orders boilers 'A' and 'B' were ordered to be filled with fresh water and steam was ordered for 10 o'clock the following morning, July 21, 1905; that owing to the delay in obtaining the fresh water it was not practicable to commence filling the boilers 'A' and 'B' until about 5.30 o'clock A.M. July 21, and at about 8 o'clock A.M. they had been filled to high steaming level.

"That at about twenty minutes after 9 o'clock A.M. the steam gauge on boiler 'B' showed about 5 pounds of steam pressure, and at this time oiler Frank De Courtani, acting as water tender, directed D. N. Holland, fireman, second class, to close the air cock on boiler 'B'; that the said Holland climbed up and closed a valve, and almost immediately the steam gauge on boiler 'B' failed to register any pressure; that this was apparently not noticed by either the water tender or the fireman, and no attention appears to have been paid to the fact that the steam gauge failed to register, but they kept on working the fires and firing heavily; that when the steam gauge on boiler 'A' showed 135 pounds there was no pressure showing on the steam gauge of boiler 'B.'

"That at about a quarter to 10 o'clock A.M., the engines were turned over, using steam from boilers 'C' and 'D'; that as it was not thought that steam would be ready in boilers 'A' and 'B' before early in the afternoon, it had been decided to get under way and leave the harbor under boilers 'C' and 'D,' but steam appears to have formed much more rapidly that it was thought possible, and boiler 'A' was connected with boilers 'C' and 'D' at about twenty minutes after 10 o'clock A.M.; that no pressure was showing on the steam gauge of boiler 'B' at this time.

"That about this time a small leak developed in No. 1 furnace of boiler 'B,' and coal-passer A. J. Worthen was sent on deck by De Courtani, the acting water tender, to inform the boilermaker about the leak and request him to come below and attend to the same; and just about this time, as Worthen was leaving Dustin, the boilermaker, who was, we believe, on the berth deck, the explosion occurred.

"That no one seems to have noticed any escape of steam from the safety valves of any of the boilers, and no one can state that any of the safety valves blew off at any time that morning.

"That we can find no record of the safety valve of boiler 'B' having been overhauled since July, 1904, nor any positive evidence of it having been done, though orders had been given for this to be done in March, 1905; that there is no record of the sentinel valves having been overhauled since July, 1904; that the safety valves were set at 145 pounds, but *en route* from Honolulu to this port orders were given to carry the steam pressure at from 130 to 135 pounds, and not to exceed the latter, but the safety valves were not changed; that this order had been clearly understood; that the hand gear for lifting the safety valves was not in working order, and there is no record or direct evidence that the safety valves had been tested in accordance with the navy regulations."

Following the statement of its findings, the Court of Inquiry gives this opinion:

"The court is of the opinion that the explosion was caused by excessive steam pressure in boiler 'B,' which came about first by shutting the valve connecting the boiler with the steam gauge, instead of the valve on the air cock alone, as was intended; so that the steam gauge did not indicate the pressure in the boiler; second, by unusual and heavy firing in the boiler to get up a pressure which the gauge failed to show; third, by the failure of the sentinel and safety valves to lift at the pressure for which they were set, and the pressure increased without relief until it was beyond the strength of the boiler, which gave way in its weakest part, afterward found to be the corrugated flue of No. 2, the lowest or middle furnace, which collapsed."

As we have repeatedly stated in discussing not only this particular disaster but other features in connection with engineering in the United States Navy, the present is above all things an age of specialists; and what the Navy needs for the work connected with engineering duty on its ships is, primarily, a corps of specialists, whose entire training has tended toward the one end of fitting them for the duties which, in the service to which they are accredited, they are called upon to perform. The requirements of that service are continually increasing, as is evidenced by the fact that the latest ships of any size in the Navy have machinery plants of from 16,000 to 25,000 horsepower and upward, as compared with the plants ten years ago, which exceeded in only a very few instances 10,000 horsepower. As a direct effect of this, any change in the personnel should be toward a decided increase in every respect, not only in numbers, but also, and in perhaps larger degree, in general efficiency as well.

It would be idle to look to the naval academy for this. The situation demands instant relief, and no man leaving the academy could in less than five years from his date of graduation be safely entrusted with such responsibilities as are now lying around loose and uncared for—sad experience has proved that—and those five years must needs be spent in earnest and diligent work, actually in an engine room. It is safe to say that, were the entire equipment of the academy devoted to this sole purpose, at least ten years would elapse before we had an engineering force commensurate with our requirements—both quality and quantity considered. The only solution suggested, which appears to us to bear the hall-mark of sanity, is to open the door for the introduction of men from civil life. Not only this, but it will be found necessary to insure them treatment due a white man—not that usually accorded a yellow dog. Men possessing the requisite qualifications are men of standing and character. No other will do. This fact must be recognized. And such men will not enter the service unless they can be assured as considerate treatment as their training (in our great technical schools), their abilities, and their characters would provide them in their usual vocations ashore.

It is not at all necessary that the Navy should return to anything of the same general nature as the old engineer corps, which was abolished by the Personnel Law of 1899. We do not want a return to conditions in which the bitter feelings (on account of social matters and questions of rank and priority) between line officers on the one hand, and engineer officers of equal training, gentlemanliness, and capacity, on the other, furnished a beautiful target for cartoonists and professional humorists. The case is one where military titles, fuss and feathers, and gold lace, should not be allowed to dictate policy. The respect and dignity which the position of engineer on one of our large naval vessels should command can be attained only by granting to that officer privileges and authority commensurate with the responsibility which he is called upon to assume; and until the department and Congress look this matter squarely in the face and realize the truism of the above statement we cannot expect much relief. It is beyond all question that we *must* have a competent engineering force, and that in order to obtain it we must sacrifice, if necessary, all pet prejudices entertained by junior officers of the line in favor of their intrinsic, indisputable, and immense superiority over men whose duties require them to take care of machinery, in the proper operation of which they are liable to get their hands dirty. The general snobbishness responsible for the conditions which brought about the law of 1899 is, in many respects, attributable to the fact that officers of both the Army and the Navy have in many cases, particularly when they are quite young, come to look upon themselves as beings quite removed from ordinary personages, and to assume that the gold buttons which they wear entitle them to the universal obeisance of mankind.

ABSTRACT FROM RULES AND REGULATIONS OF THE AMERICAN BUREAU OF SHIPPING FOR SOUND, LAKE, BAY, AND RIVER STEAMERS, YACHTS AND TUGS.

EDITION OF 1904.

ARRANGED BY HARRISON S. TAFT.

(Continued.)

23. Riveting.

1. The style of riveting used in the longitudinal seams of the shell plating forward and aft is to be of the same type as that of said seams amidships.

2. With plates of different thickness the thicker of the two is to determine the size of the rivets used.

3. Lapped butts are to have the same style of riveting as if butt straps were adopted.

4. All double-riveting to be chain fashion, except for Bar Keels, Stems, and Stern Posts, where zigzag riveting is to be used.

5. Rudder rivets are to be of the same diameter as those used in the lower edge of the main sheer strake.

6. Bar keels, when 5 inches or more in depth, are to have a double zigzag riveted connection to the garboards.

7. Bar keels, stem and stern-post rivets are to be 1-4 larger in diameter than those used in the upper lap of the garboards.

8. The doubling clips to the frames at the margin plate in double-bottom vessels are to have 3 rivets in each flange on each side of said margin plate.

9. All angle-bosom clips at the reverse-bar butts are to have 2 rivets on each side of said butt. Those at all keelson and stringer angle-bar butts are to have 3 rivets on each side of said butts.

10. All angle clips on the frames and floors in the way of the keelson and side stringer angles are to have a 3-rivet connection to said floors and frames.

11. The Following to be Single Riveted:

(*a*) Longitudinal seams of all shell plating, except the garboards and the lower seam of the main sheer strake, when the weight of midship plating does not exceed 16 pounds.

(*b*) Upper lap of garboards, and the lower longitudinal seam of the main sheer strake, when the weight of the midship plates of said strakes is under 16 pounds.

(*c*) Upper edge of all main sheer strakes.

(*d*) Fore-and-aft seam strips of flush shell plating, when the weight of the midship plates does not exceed 22 1-2 pounds.

(*e*) All butts of the shell plating; of the deck stringers and deck plating; of all water-ballast tanks and inner-bottom plating; when said plating is under 7 1-2 pounds.

(*f*) Bulwark butts in all cases.

12. The Following to be Double Riveted:

(*a*) All floor-plate butts, when tonnage does not exceed 500 tons.

(*b*) Diagonal tie-plate connections to deck stringer plates.

(*c*) Butts of the deck plating, except in bulk freight vessels of the Great Lakes.

(*d*) Lower strake of the centerboard-trunk plating, when flanged to a flat plate keel.

(*e*) All flat-plate keel connections to adjoining strakes.

(*f*) Longitudinal seams of all shell plating, except the garboards and the lower seam of the main sheer strake, when the weight of midship plating exceeds 16 pounds.

(*g*) Upper lap of the garboards and the lower longitudinal seam of the main sheer strake, when the weight of the midship plates of said strakes is 16 pounds or above.

(*h*) All butts of the shell plating (except Bulwarks); of the deck stringers and deck plating; of all water-ballast tanks; and inner-bottom plating; to be at least double riveted, when said plating is of 7 1-2 pounds or more in weight.

(*i*) Hurricane-deck stringer plates and all outside plating in way of said decks above the main sheer strake.

(*j*) Fore-and-aft seam strips of flush shell plating, when the weight of the midship plates is over 22 1-2 pounds.

TABLE 9.—RIVETING SCHEDULE FOR SHELL PLATING.

Type of Vessel.	Sailing Vessels.		Vessels of the Great Lakes.			
			Bulk Freight.		Engines Fitted Aft.	
Tonnage.	500 under 1,000.	1,000 and above.	Under 2,000.	2,000 and above.	1,500 and under.	Over 1,500.
Butt straps of:						
Sheer strake	TR — $\frac{1}{2}$ L	TR — $\frac{1}{2}$ L	TR — $\frac{3}{5}$ L	TRT	[a] TR — $\frac{3}{4}$ L	TRT
First bilge strake	TR — $\frac{1}{2}$ L	TR — $\frac{1}{2}$ L	TR — $\frac{3}{5}$ L	TRT	[a] TR — $\frac{3}{4}$ L	TRT
Second " "	......	TR — $\frac{1}{2}$ L	TR — $\frac{3}{5}$ L	TRT	[a] TR — $\frac{3}{4}$ L	TRT
M D stringer	......	TR — $\frac{1}{2}$ L	......	......	.....	......

[a] Measured from stern post.
TR = treble riveted. TRT = treble riveted throughout.
— $\frac{3}{5}$ L = for $\frac{3}{5}$ length amidships.

13. The Following to be Treble Riveted:

(*a*) All floor-plate butts, when tonnage exceeds 500 tons.

(*b*) All butts of flat-plate keels.

(*c*) All butts of continuous plate keels and keelsons.

(*d*) All butts of middle-line keelsons and side longitudinals.

(*e*) All butts of shell plates 54 inches or more in width.

(*f*) Butts of the deck plating in bulk freight vessels of the Great Lakes.

(*g*) All butts of the shell plating for 3-4 vessel's length forward from the stern post in vessels upon the Great Lakes with machinery located aft.

14. Countersinks should be in depth not less than 3-4 the thickness of the plate or the angle-bar flange.

TABLE 10.—RIVETING OF INNER BOTTOM PLATING.

Tonnage.	Under 2,000.	2,000 under 3,000.	3 000 and above.
Edges of the middle line strake	Single.	Double.	Double.
Edges of strakes adjoining the middle line strake	"	Single.	"
Edges of all remaining strakes	"	"	Single.

All butts of said plating to be double riveted throughout.

IN VESSELS UPON THE GREAT LAKES WITH MACHINERY LOCATED AFT.

All butts of said plating to be treble riveted for ½ length forward of engine room.

When built for transporting of heavy dead weights	Over 2,000, under 3,000 tons. T R — ½ L amidships.	3,000 tons or above. T R T

T R = treble riveted. T R T = treble riveted throughout. — ½ L = for ½ length amidships.

24. Double Bottoms.

1. Double bottoms may be of the following types:

(*a*) Longitudinal girders on top of floors.

(*b*) Continuous side longitudinal plate girders extending from the shell to the inner-bottom plating.

(*c*) Continuous floor plates with intercostal side girders.

2. Longitudinal Girders on Top of Floors. Said girders are to be spaced not over 42 inches apart. They are to be of the same weight as the floor plates; with a continuous angle bar, equal to the reverse bars in size but to the end frames in weight, worked on the upper and lower edges for securing said girders to the inner-bottom plating and to the reverse bars with their reverse clips. In lieu of the reverse clips vertical stiffeners may be worked, extending from the top of the girder plate to the lower side of the floors. Said girders are to be worked continuously through all watertight floors.

3. Continuous Side Longitudinals.

(*a*) The plating of said longitudinals need not exceed 22 pounds. Said longitudinals are to be secured to the inner-bottom plating with a continuous angle bar of reverse-bar flange size, but equal to the end frames in weight. Bracket plates of the same weight as the girder plates are to be worked at alternate frames at top and bottom on each side of the girder plates; being secured to the inner bottom plating and longitudinals with angle clips of the same scantling as the bars on top of said longitudinals. The clips connecting said brackets to the center-line girder shall be worked double.

(*b*) When the tonnage is 1,000 and above, solid manhole intercostal floor plates of the same weight as the side longitudinals are to be fitted on every eighth frame; having double clips of reverse-bar size to the longitudinal girders, but a single clip of the same scantling as the longitudinal top bars to the inner-bottom plating.

4. Solid Floors.—When double bottoms are built with solid floors, said floors are to extend from the shell to the inner-bottom plating, and from the center line to the margin plate. They may be 2 1-2 pounds less in weight than ordinary floors, except at bulkheads and under the engine bed, where full weight must be maintained, with double reverse bars on top. An intercostal-plate girder of the same thickness as the inner-bottom plating is to be worked midway between the center line and the margin plate; being clipped to floors, shell, and inner-bottom plating with angle clips equal to reverse bars.

5. All lower bilge keelsons may be omitted in way of all inner bottoms.

6. When double bottoms are not worked continuously the usual bilge and other keelsons must be worked throughout the spaces where no double bottom is worked. Such keelsons are to lap the inner-bottom girders, so as to maintain the longitudinal strength.

7. The margin plates may be flanged to the shell plating, or be secured to same with a continuous angle bar (the frame being cut), or by watertight intercostal staples worked around the frames and reverse bars.

8. When the frames are cut, bracket plates, equal to the weight of the margin plates, are to be worked on both sides of the margin plate at every frame. Said brackets shall have a four-rivet connection to the frames and be secured to the margin plates by angle clips equal to reverse bars, with at least four rivets in each flange.

9. When the inner-bottom plating is not worked through the watertight bulkheads at the ends of the machinery space, said plating is to be connected to said bulkheads with a single bar equal to the reverse bars.

10. All inner-bottom plating, except the margin plates and the plating in the machinery space, is to be of the same weight as that of the lower half of watertight bulkheads. It shall be worked fore-and-aft in length equal

to the shell plating. The margin plates and all the plates in the machinery space, except those under the engine bed, are to be 2 1-2 pounds heavier than said bulkhead plating, if said bulkhead thickness is under 17 pounds. When said bulkhead plating is 17 pounds or above, the inner-bottom plates throughout are to be of the same weight as the bulkhead plating. When the weight of the inner-bottom plating is and above 15 pounds, said plating fore-and-aft of the 1-2 length amidships can be reduced by 2 1-2 pounds. The plating under the engine bed is to be of approved thickness.

11. Manholes may be cut in all non-watertight floors, longitudinal girders, and inner-bottom plating to allow of ready access to all parts of the double bottom.

12. Solid watertight floors with double frame bars are to be fitted under all watertight bulkheads. Floors under the engine bed are to be of the solid manhole-floor type, and shall be fitted at every frame.

13. In engine and boiler rooms of vessels of 1,000 tons and above, solid intercostal floor plates are to be fitted on every third frame. A solid floor must be located under all boiler bearings.

14. A center line watertight keelson should be worked in every case; secured by double angle bars to the inner-bottom plating.

15. Fore-and-Aft Peaks. A watertight deck or flat of the same weight as the lower half of watertight bulkheads should be worked on the lower or main deck beams when it is intended to carry water ballast in either the fore or aft peak. Auxiliary beams should be fitted between the regular beams under said plating, with knee brackets equal to the weight of the adjoining deck stringer, with at least a four-rivet connection to both the frames and the beams.

16. All watertight ballast tanks or compartments, except the fore-and-aft peaks, which extend to the main or lower decks, are to have a center-line bulkhead for the entire depth of said tank. Said bulkhead is to equal top plating of tanks and be well stiffened, similar to all other bulkheads.

17. All water ballast and inner-bottom compartments must be tested with a head of water extending at least two feet above the deep-load water-line.

25. Hatchways and Deck Openings.

1. Coaming plates at all deck openings should extend to the lower side of the deck beams to which they are secured; being equal to the thickness of said beams. All coaming plates of freight hatches and deck houses should have rounded corners. The freight hatches on a weather deck are to have their coaming plates standing at least 12 inches above the deck planking with a half-round beading on the upper edge. Suitable iron supports are to be fitted on the inside for carrying the hatch covers.

2. When a deck house is fitted over an engine or boiler opening on the weather deck the coaming is to stand at least 12 inches above the deck planking; but 30 inches if no deck house is fitted over said openings. In the latter case a half-round beading is to be worked on the outside of the top edge of the coaming, with a suitable support on the inside of the coaming around the fire room hatch so as to carry a metal grating.

3. There shall be an angle bar equal to the main frames, securing the coaming plates to the steel deck or tie plates, extending all around the hatch; the upper edge of the flange which is secured to the coaming plate being caulked watertight.

4. When freight hatches are over 12 feet in length or width, the coaming plates are to be 25 percent thicker than the beams to which they are secured; and are to stand at least 16 inches above the deck planking. The tie plates at the sides of the hatches are to be double their tabulated width for one beam space beyond the ends of the hatch opening. If a steel deck is worked the strake of plating next to said coamings is to be 2 1-2 pounds heavier than otherwise for same distance.

TABLE II.—HATCH BEAMS AND CARLINGS.

Hatch Length in Feet	a. Hatch Beams.	Hatch Width in Feet.	c. Hatch Carlings.
Over 16 under 22	b. One web plate shifting beam.	10 and under.	One.
22 not over 30	b. Two " " " "	Over 10 not over 15.	Three.
30 and above	Plans to be submitted.	Over 15.	Plans to be submitted.

a. Besides the above increase in deck ties or deck plating.

b. Of same weight as coaming plates; in depth at least $\frac{3}{8}$ whole depth of said coaming plates; fitted with double top and bottom angle bars equal to reverse frames; bolted to double clips on side coamings; arranged so as to support fore and aft wooden carlings.

c. Supports for same, with a fore-and-aft bearing surface of at least two inches deep to be riveted to end coamings.

5. Wooden hatch covers are to equal the thickness of the main deck planking.

6. In vessels on the Great Lakes with extreme wide hatches and low coamings, the side coaming plates should extend below the deck beams a distance equal to the depth of said beam so as to be secured to the fore-and-aft stringer worked under said beam at side of hatches. The vertical stringer must equal the scantling of the deck beams, and the coaming plate must at least equal the thickness of the deck stringer which adjoins them, with an angle bar securing them to said stringer. (Rather an obsolete practice in view of present "Lake" methods.)

26. Deck Houses and Skylights.

1. Deck houses fitted on a weather deck over an engine or boiler opening must be of steel, of at least the same thickness as the upper half of watertight bulkheads. Stiffeners, equal to the reverse bars, are to be spaced not over 30 inches apart, with roof beams of same scantling located at every stiffener.

2. In hurricane-deck vessels, a steel trunk with a coaming plate is to be fitted between the hurricane and second

decks around the opening for the machinery. Said coaming plate at the second deck shall be similar to that for a weather-deck opening; that on the hurricane deck being of approved construction and height.

27. Wooden Decks and Ceilings.

1. The margin plank is to be of some approved hard wood.

2. All steel decks must be well painted before a wooden deck is laid thereon. When an oak deck is worked, felt or some other insulating material should be fitted between the steel plating and the wood decking.

3. A reduction of 1-2 inch from the tabulated thickness will be allowed in a wood deck which is laid on a steel deck extending the entire length of the vessel.

4. The main deck planking is to be fastened to the deck beams with galvanized screw bolts, with nuts on the underside; the heads of the bolts being bedded with oakum and white lead.

5. The deck planking of the hurricane, full poop, and enclosed bridge house decks may be 1-2 inch less in thickness than that of the main deck; but not to be less than 2 inches thick. It may be secured to the deck beams with wood screws.

6. The deck plating of a topgallant forecastle, raised quarter and fore deck, is to be similar in all respects as to thickness and fastenings to that of the main deck.

7. The hurricane deck of passenger vessels may be of the tongued and grooved type not less than 1 1-8 inches thick, being covered with canvas painted, so as to make it perfectly watertight. Said deck planking can be nailed to wooden battens fastened on top of the iron beams. When said iron beams are fitted on alternate frames a wooden beam should be worked between said iron beams. The cabin floors of yachts can be built in the same manner.

8. The lower deck of a hurricane-deck vessel is to be of the same thickness as that of the main deck: but it need not exceed 3 inches.

9. All parts of cargo spaces are to be close ceiled to the upper turn of the bilge, with battens worked berth and space above said point. In vessels engaged entirely in the coal, ore, or grain trade, said battens may be omitted.

10. A wooden ceiling, at least 2 1-2 inches thick, is to be worked over all inner-bottom plating, in such a way as to leave a drainage space between the steel plating and wooden ceiling.

28. Rudders.

The pintles are to be spaced from 4 1-2 to 5 feet apart. In vessels of less than 500 tonnage said pintles can be forged solid on the rudder frame, but for vessels of 500 or more tonnage they should be of hard steel let into the frame. The rudder frame should have a solid stay in way of the pintles. Side plates should be of the same thickness as the lower half of bulkhead plating, the space between the side plates being filled with wood. Rudders should be arranged so that they can be unshipped while the vessel is afloat. The pintles and the stock of a balanced rudder are to be 30 percent larger in sectional area than otherwise. Balanced rudders should have a thrust bearing at the main deck.

29. Windlass, Pumps, and Valves.

1. An iron windlass is to be fitted on all vessels requiring cables 3-4 inch in diameter or above. All other vessels should have a suitable capstan for handling the chains.

2. Sailing vessels under 200 tons are to have at least one hand bilge pump. When of 200 tons or above, two such pumps must be provided. Tug-boats are to have one hand pump for pumping the bilge. All of said pumps to be located on the upper deck.

3. Sluice valves, worked from the upper deck, are to be fitted to all watertight bulkheads, except to the forward collision and aft peak bulkheads, which are to be fitted with brass cocks.

4. A sounding pipe must be located in each watertight compartment, with a doubling plate to the shell plating under same. Two air pipes are also to be fitted to each inner-bottom compartment.

5. Brass cocks are to be fitted next to the shell plating on all lead pipes drawing from the sea.

6. Soil pipes are to be of iron up to the deep load water-line, with a foot valve riveted to the shell plating and caulked watertight.

7. All metal work should have three coats of good paint. The inside of the shell plating should be cemented to the turn of the bilge.

8. Means must be provided for the proper ventilation of all compartments not ventilated by skylights, side ports, etc. Storm shutters are to be fitted to all dead lights in cargo spaces.

30. Life Boats.

Tonnage............	Under 100.	100 to 500.	500 to 1,000.	1,000 and above.
Number of boats....	1	2	3	4

One boat should be of sufficient size to transport the stream anchor.

31. Hurricane-Deck Vessels.

1. The depth for calculating the tonnage, and for obtaining the scantling number for frames, reverse bars, and floors, is to be taken to the deck next below the hurricane deck. The depth for regulating the ratio of depth to length and for calculating the equipment number is to be measured from the base line to half deck space between the hurricane deck and the deck next below said hurricane deck, at sides of the ship.

2. The hurricane-deck sheer strake should maintain its midship thickness throughout. The side plating between the main and hurricane-deck sheer strakes may be reduced by 2 1-2 pounds for 1-4 length at the ends, when its midship weight is 12 1-2 pounds or over.

3. Beams of the hurricane deck should be placed on alternate frames if the thickness of the deck plank will permit of caulking. When said deck is built of thin wood with a canvas cover a wooden beam must be worked between the iron beams that are worked on alternate frames.

32. Full Poops, Topgallant Forecastles, Inclosed Bridge Houses.

1. Deck beams, plate stringers, and tie plates are to be governed by the same rules as stated for hurricane-deck vessels.

2. The plating at the front of a full poop and inclosed bridge house is to equal the lower half of watertight bulkheads, with stiffening bars, equal to frames, spaced not over 30 inches apart. The coaming plate at the front of a full poop is to be 5 pounds heavier than said bulkhead plating, and shall stand at least 9 inches above the deck planking. The angle bar connecting said coaming plate to the deck plating is to stand at least 1-2 inch above the deck planking.

3. The depth for regulating the tonnage scantling for frames, reverse bars and floors, and for determining ratio of length to depth, is to be measured to the main deck at sides. When the length of either of the above structures, or of the combined length of any two, or of all of said structures exceeds 1-2 the vessel's length, the scantling tonnage increased by 1-8 of itself is to be the equipment number.

33. Raised Quarter and Raised Fore Decks.

1. The front of a raised quarter deck is to be of the same thickness as the outside shell plating in way of said quarter deck above the main-deck sheer strake, at the fore end of said structure. When said quarter deck stands more than 18 inches above the main deck its front must have stiffeners equal to the main frames, spaced not more than 30 inches apart. The angle bar connecting the bulkhead plating to the main-deck plating must stand above the deck planking so as to be caulked watertight. When no deck planking is worked said bar must equal the scantling of the main frames.

2. The after end of a raised fore deck is to be of same thickness as the plates in the upper half of a watertight bulkhead. Otherwise to be similar to the bulkhead at the front of a raised quarter deck.

3. Companionways must not be cut in front of a raised quarter deck; or in the aft ends of a raised fore deck, except when said bulkhead extends from the floors to the raised fore-deck beams.

34. Spacing of Rivets.

	DIAS.
1. Laps or seams of the shell plating	4
2. Laps or seams of all internal watertight work, chain fashion	4 1-2
Center to center of rows	2 1-2 to 3
3. Beam knees: to have at least 4 rivets to frames and beams	4 1-2 to 5
4. Bar keels; stems; stern frames; rudder plates, zigzag fashion	5
Center to center of rows	2 to 2 1-2
5. Frames to shell plating and floors; reverse bars to floors and frames; keelson and hold-stringer angle bars; all bulkhead, trunk casing, and centerboard-trunk stiffeners; and all similar non-watertight work	8

6. Treble-riveted butts to have three complete rows.

7. Shell clips to have four rivets in each flange.

8. No rivet is to be nearer the seam, butt, or edge of a plate or angle bar than its own diameter.

TABLE 12.—AMERICAN BUREAU OF SHIPPING. WIDTH OF BUTT LAPS AND BUTT STRAPS. SPACING OF RIVETS. FOR SOUND, LAKE, BAY AND RIVER SERVICE AND YACHTS AND TUGS.

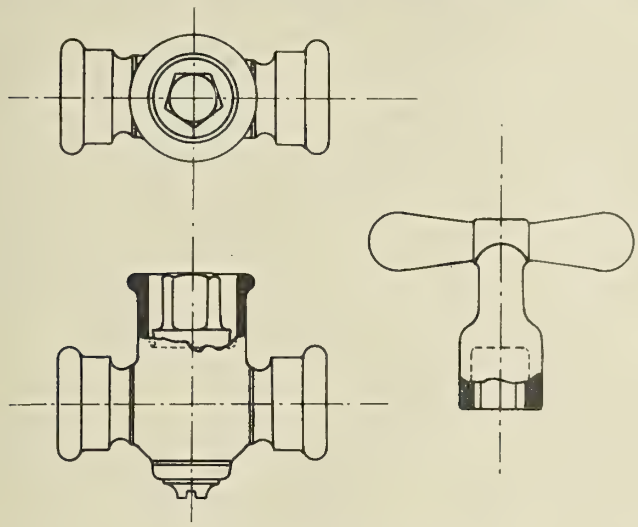
	Weight of Plate. Lbs.	Diametral Pitch.	4 to 6	8	10	12 to 16	18 to 22	24 to 28	30 to 34	36
	Diameter of Rivet. Inches.		3/8	7/16	1/2	5/8	3/4	7/8	1	1 1/8
Widths of:	Single riveted butt lap	....	1 3/8	1 5/8	1 7/8	2 1/4	2 5/8	....	....	....
	Double " " "	....	2 1/8	2 1/2	2 7/8	3 3/4	4 3/8	5 1/8	5 3/4	6 1/8
	Treble " " "	....	....	....	....	....	....	....	....	....
	Single " " strap	7	2 5/8	3 1/16	3 1/2	4 3/8	5 1/4	6 1/8	7	7 7/8
	Double " " "	....	4 1/4	5 1/8	5 3/4	7 1/4	8 1/2	10 1/4	11 1/2	13
	Treble " " "	....	6 1/2	7 1/8	8 1/2	10 5/8	12 3/4	15	17	18 1/2
	Single " seam lap	....	....	....	....	....	....	....	....	....
	Double " " "	....	....	....	....	....	....	....	....	....
	Single " edge strip	7 to 8	2 5/8	3	3 1/2	4 1/8	5 1/4	6 1/8	7	7 7/8
	Double " " "	11 1/2 to 12 1/2	....	.	....	7 1/4	8 3/4	10 1/8	11 1/8	13
Spacing of rivets.	1.—Center of rivet from edge of plate	1 1/2	9/16	11/16	3/4	15/16	1 1/8	1 5/16	1 1/2	1 11/16
	2.—Zigzag riveting: center to center of rows	2 to 2 1/2	....	....	....	....	....	....	.	....
	3.—Chain " " " " " "	2 1/2 to 3	....	....	....	....	....	....	....	....
	4.—Seams or laps of the shell plating	4	1 1/8	1 3/4	2	2 1/2	3	3 1/2	4	4 1/2
	5.— " " " " all inside watertight work	4 1/2	1 11/16	2	2 1/4	2 13/16	3 3/8	3 15/16	4 1/2	5 1/16
	6.—Beam knees	4 1/2 to 5	....	....	....	....	....	....	....	....
	7.—Bar keels; stems; stern posts; rudder plates	5	1 7/8	2 3/16	2 1/8	3 1/8	3 3/4	4 3/8	5	5 5/8
	8.—Ordinary frames to the shell and floors; reverse bars; keelson and stringer bars; bulkhead stiffeners: all non-watertight work	8	3	3 1/2	4	5	6	7	8	9

A Bennington Suggestion.

Editor Marine Engineering:

As it appears from the report of the board of investigation the probable primary cause of the lamentable accident to the U. S. gunboat *Bennington* was the "shutting off" of the steam gauge on the boiler, the idea suggests itself to me that it would be advisable to provide a means of preventing a repetition of such a deplorable mistake. While it is quite true that an accident of this kind might not happen again in a century, the fact remains that it *has* occurred, and any means of preventing another accident of the kind would add still further to the numerous devices for the safety of boilers, which are necessitated by that never-to-be-neglected factor, the "personal equation."

It has occurred to me that, in lieu of the ordinarily adopted handled cock or valve, it would be well to use a cock similar to the one shown in the accompanying sketch, wherein it will be



seen at a glance that it cannot possibly be closed without a special handle or key. This handle or key should be kept in the engine-room desk, or other place where it can be accessible only to the engineer of the watch. It is extremely seldom that it becomes necessary to shut off a steam gauge from the boiler, and when an occasion of this kind does arise, the engineer in charge should be the one to do it, and time can always be taken to go into the engine room for the key. There is nothing original about such a device, as will be mutely testified by the thousands of gas and water plugs, steam radiator valves, etc., in common use; but had such a cock been fitted to the steam-gauge pipe on the *Bennington*, the water tender, or whoever it was who attempted to close the air cock and succeeded in shutting off the steam gauge, would have been thwarted in ignorantly making a mistake which led up to the most frightful accident to steam machinery that has occurred in modern times. Attention to details which may appear trifling is, as everyone will admit, the secret of success in the safe operation of machinery of all types, and the foregoing suggestion is offered to the engineering profession for its consideration in that line.

C. A. McAllister,

Chief Engineer, U. S. R. C. S., Engineer-in-Chief.

The Bureau of Navigation of the Department of Commerce and Labor reports that there were built in the United States during the month of July 116 vessels of an aggregate of 12,706 gross tons. As this list included one ship of 6,363 tons, or more than half the total, it will be seen that the remainder consisted of 115 ships of an aggregate of 6,343 gross tons, or an average of *55 tons* each.

The figures for August are a little more encouraging, there having been 107 vessels of an aggregate of 44,028 gross tons, of which five, each of more than 4,000 tons, accounted for a total of 29,221 tons. This leaves a balance of 102 vessels with an aggregate of 14,807 tons, or an average of *145 tons* each.

The thirteenth general meeting of the Society of Naval Architects and Marine Engineers will take place in New York city at 10 A.M. Thursday, November 16, 1905. The meetings will be held in the Auditorium at No. 12 West Thirty-first street, the sessions continuing through Thursday and Friday, November 16 and 17. The banquet following the sessions of the meeting will be held at Delmonico's, Fifth avenue and Forty-fourth street, on Friday evening, November 17, at 7 o'clock. The programme giving the list of papers to be read at the meeting will be ready about October 15.

Mr. H. F. J. Porter has just opened an office in the Metropolitan Building, 1 Madison avenue, New York, N. Y., for a consulting industrial engineering practice in connection with installing modern methods of organization and management. Mr. Porter has had a valuable experience extending through more than a quarter of a century of work of great variety in character and scope, and should make a splendid success at his new undertaking.

ENGINEERING SPECIALTIES.

Automatic Safety Life-Boat Handler.

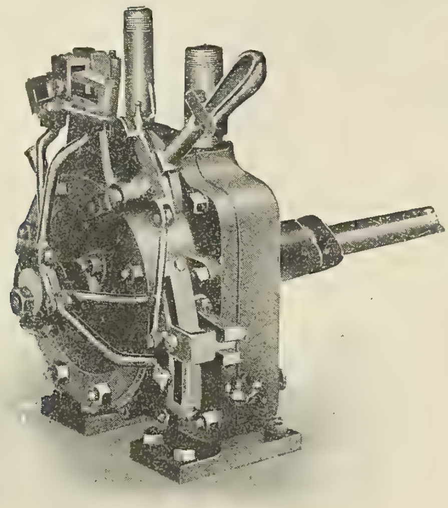
The Automatic Safety Life-Boat Handler is the result of some ten years' work and experience of a practical sailor, Captain Frank W. Irvine, late of the Ward Line. It is a noticeable fact that, although many and important improvements have been made in the construction of vessels and steamships and their equipments during recent years, the facilities for handling life-boats, so important in saving lives, have improved very little during the last century. The hoisting, swinging out, and lowering away of life-boats by this device can be done in a half to one minute in all kinds of weather by only two men. Guys are not needed. The old method of doing this work requires ten men from seven to ten minutes.

When life-boats are most needed as a rule electricity or steam cannot be depended upon. This gear, which is worked by hand, can be attached to any davit now in use. After the boat is hoisted the davits swing out automatically, no pulling or pushing is required, and the lowering away of the boat is entirely in the safe control of the two men in charge of the gears. The gear may be used on life-rafts as well as on life-boats. The usual confusion and delay is avoided and the crew have ample time for careful inspection of the boats and the care of the passengers. The two men necessary to handle the gear need not be sailors; simple instructions are attached so that any two passengers, in an emergency, can lower the boat.

The two machines required for each life-boat occupy a deck space beside each davit of 14 inches by 24 inches. The only additional deck space used in handling the boats is that required for a man at each machine, who works the machine and the falls. Wire rope is used for the falls, as a further protection against fire. In cold weather ropes are generally frozen and often full of kinks and turns, which greatly handicap the work of lowering the boat Wire will last much longer and will, in the course of time, save the cost of gear, as it is necessary to renew rope at least once a year. The device is being handled by the Barcus-Hallam Company, 111 Fifth avenue, New York.

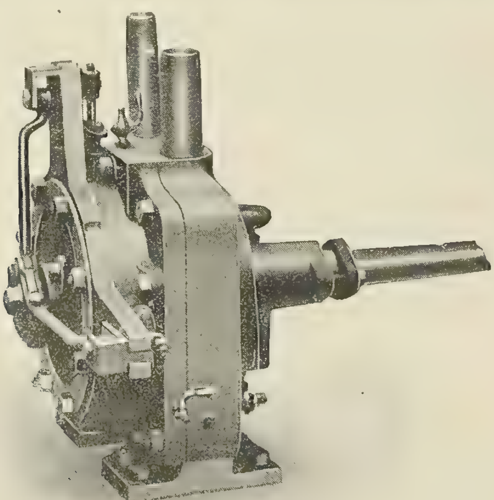
Werner Fluid Motor.

Strictly speaking, this motor consists of two distinct reciprocating engines so placed that the strokes of their pistons are at right angles to one another. There are two cylinders, one within



REVERSING MOTOR.

the other; two pistons, also one within the other; a crank pin and a crank shaft in common for both pistons; two valves; two valve rods; two eccentrics; two links, etc. The outer casing constitutes the outer cylinder for the outer piston, and the latter constitutes the inner cylinder for the inner piston. The outer piston only reciprocates, while the inner piston travels in a circular path with



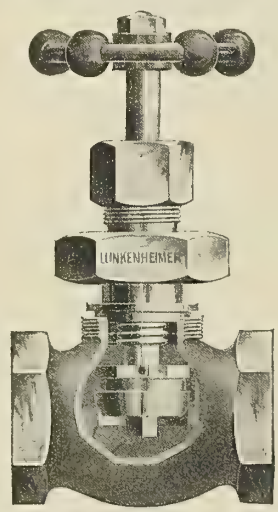
NON-REVERSING MOTOR.

reference to the main body of the machine. The inner piston reciprocates only with reference to the outer piston and its to-and-fro motion is on line perpendicular to the upper and lower bearing surfaces of the outer piston and not perpendicular to the line of movement of the outer one.

Steam, air, or whatever the motive fluid may be, is admitted successively to both ends of each piston, thus giving the motor shaft four successive impulses for every revolution. The valve gear is practically the same as is used on the locomotive, there being two double D-valves in a common valve chest, two valve rods, two links, four connecting rods for the valves, and only two eccentrics instead of four. Two of these are dispensed with since the two valves lie in the same plane and in the same chest. In this gear the valves lie on the opposite side of the link arc as is generally found in the Stevenson valve gear, but the characteristic functions are identical in every respect with that of the latter. There is nothing new in this motor—only new applications of principles already known.

Improved Regrinding Valves.

A number of desirable improvements on the Lunkenheimer (Cincinnati, O.) regrinding valves have been made, resulting in an increase in the weight of the valve, as an additional precaution against rough handling while attaching. The medium pattern valves are guaranteed to stand a working pressure of 200 pounds, and the extra heavy pattern up to 300 pounds per square inch. The shape of the valve has also been altered, increasing the area through the valve and permitting an unobstructed passage through same, the area being now more than equal to that of the connecting pipe. To insure a perfect and strong joint between the pipe and valve, the pipe threads have been made considerably longer, thereby obviating the danger of stripping threads. All sizes of the valves now have lock nuts on the hand wheels, which facilitates the taking apart and assembling of the valve for repairs, etc.



Referring to the sectional illustration, it will be noticed that the hub which carries the operating stem is secured to the body by a union connection, which, in turn, screws over the shell of the valve body. By means of this construction it is impossible for the hub and the body to become corroded together, as the thread which holds the union ring to the body is protected at all times from the action of the steam, the joint being made between the flange on the hub and the neck of the body.

To regrind the valve, the bonnet ring is unscrewed, and the trimmings are removed from the body. A wire or nail is placed through the lock nut and stem, a little powdered sand, or glass and soap or oil is placed on the disc, and the trimmings are again placed on the valve and reground.

TECHNICAL PUBLICATIONS.

The Naval Pocketbook. By Sir W. Laird Clowes. Pages 947 + xxxiii. London: W. Thacker & Company, 1905. Price 7s. 6d. net.

What will probably prove to be the last of this series of very useful books is the 1905 edition of "The Naval Pocketbook," which is now in its tenth year. Our reason for assuming the immediate cessation of this series is the death of Sir W. Laird Clowes, which occurred a few weeks ago. It is much to be regretted that there is little hope for a continuation of the series, because of the fact that an immense amount of valuable information regarding warships of all the world has been collected in the little volume, which has been corrected to March 31, with addenda bringing the total up to June 9, 1905, and including such recent items as the results of the naval battle of Tsushima. The contents include a complete list of every battleship, cruiser, gunboat, torpedo boat and destroyer and submarine in all the navies of the world; notes on torpedoes; comparative fighting strength and navy expenditures of the powers; list of dry-docks; steam trials of ships; plans of a large number of the most important ships afloat; a complete index of ships by names; and the usual tables for conversions of measures between the metric and English systems.

One of the most interesting features of the book is a table contained in the preface, giving a comparative summary of the fighting fleets of the world in ships built and building.

We have received from L. Smit & Zoon, of Kinderdijk, Holland, a very interesting little book bound in cloth and containing 137 pages and 89 illustrations. While this book is primarily a house organ, and is devoted almost exclusively to the exploitation of the products of the firm which issued it, yet the illustrations and the general character of the descriptions offered render it of especial interest to marine engineers in general, and particularly to those concerned with the art of dredging, either as a designing engineer or as an operating engineer. The work is printed in six languages, which are given in the book in the following order: Dutch, French, German, English, Russian, and Spanish. A very novel index is provided in which the page numbers are set opposite the flags of the countries in which the six several languages are spoken, there being a total of 15 flags represented, this necessitating the printing of that page in five colors. The half-tones scattered throughout the work seem to be about equally divided between full-page cuts and small capitals and tail pieces, while a number of line drawings have been used to illustrate special appliances.

QUERIES AND ANSWERS.

All reasonable questions concerning marine engineering received from and signed by subscribers will be answered by the Editor in this column. All communications must bear the name and address of the writer.

Q. 298.—Kindly answer the following questions for me relative to an engine 5½-inch bore, 6-inch stroke, running 450 R.P.M., a 2-cycle gasoline motor.

(*a*) What percent of the piston displacement should the clearance be to give proper compression?

(*b*) Give the proper size and area of inlet and exhaust ports.

(*c*) Is a plunger pump more satisfactory than a rotary and why?

(*d*) What is generally taken as an average M.E.P. of this style engine?

(*e*) Is the reversing engine as manufactured by some makers reliable and sure, so that no reversing gear is necessary?

(*f*) Give me the names of some reliable marine engine reversing gears?

(*g*) Is there a patent on a gas engine piston for 2-cycle engines having a port in the side near the head to correspond with the inlet port in the cylinder, and if so what is the patent number? F. G. K.

A.—(*a*) The percentage of piston displacement taken for clearance volume should be from 30 to 35, varying with the richness of the gas. The poorer the average mixture the higher the compression should be and hence the smaller the clearance volume. This proportion will insure a pressure at the end of compression of 80 to 90 pounds, and an initial pressure after combustion of 300 or upward. Too small a clearance volume will mean too high a compression pressure, a possibility of premature ignition due to the heat developed, and greater irregularity in the motion of the engine. Too large a clearance volume, on the other hand, will mean too low a terminal pressure, liability of incomplete combustion, and loss of effect. In the case of the engine you mention, with stroke of 6 inches, the clearance length should be about 2 inches to realize good average results.

(*b*) The inlet and exhaust ports are sometimes made about equal in area, but the latter should be preferably some 30 to 40 percent the larger of the two. The size is chiefly determined by the displacement volume of the piston and the number of revolutions per minute. The problem is simply to provide an inlet passage of such area that with the slight elevation of pressure in the crank case a cylinder-full of vapor will readily enter in the small time allowed near the end of the stroke, and similarly such an area of exhaust port that the cylinder-full of spent gases will escape with rapid drop of pressure in the small time likewise allowed at the end of the stroke. Experience indicates that to fulfil these conditions the inlet port should have an area substantially as given by the formula:

$$a = \frac{NV}{36{,}000}$$

where a = area of inlet port in square inches.
N = revolutions per minute.
V = displacement volume of piston in cubic inches.

For the exhaust area some 30 to 40 percent in excess should be allowed.

For the engine you mention the inlet passage should have an area not less than 1¾ to 2 square inches, while the exhaust area should be about 2¼ square inches.

(*c*) The satisfactory operation of the circulating pump will depend more upon its actual design and construction in detail than upon the type—whether plunger or rotary. Satisfactory pumps of both types are in common use.

(*d*) The mean effective pressure of such an engine should be about 90 or 100 pounds. This results as a combination of clearance volume and compression line, quality of mixture and completeness of combustion, and area of inlet and exhaust passages.

(*e*) The only type of reversing engine which can be recommended as satisfactory (except perhaps in the very smallest sizes) is that in which a multi-cylinder engine is provided with an arrangement for moving the valve gear and sparking mechanism into either ahead or backing gear, and in which, in addition, a compressed air chamber is provided for giving the necessary initial impulse in starting. Further reference to this point will be found in MARINE ENGINEERING for September in the article on "Motor Boats." With such an arrangement and a little skill in manipulation, the handling of a gas engine becomes very similar to that of a steam engine provided with the usual type of reverse gear.

(*f*) We cannot recommend by name specific types of reverse gear in these columns. We should advise you to send for circulars from the various advertisers in this journal and to determine for yourself on the plain merits of the various arrangements offered.

(*g*) We cannot search patent records for items such as that asked for. Any patent attorney will be able to aid you in regard to such matters.

Q. 302.—I always put the zincs in the boiler in baskets and usually fasten them with bolts, but I have about 15 baskets without the bolts to fasten the zincs on. It is claimed that the zincs must be fastened so as to form a metallic contact. From my experience with the 15 zincs taken out without bolts, they are just as much eaten away as the others, so I claim that they don't need the bolts. Now I want to know if it makes much difference whether they are fastened with bolts or not. W. B. M.

A.—Zinc slabs should be provided in dimensions of about one-half square foot with a thickness of one inch for each 25 or 30 indicated horsepower, and should be well distributed throughout the boiler. They are often suspended from the stays, and care should be taken that the zinc, the supporting strap, and the stay touch one another with a good bright metallic contact in order to insure the permanency of the galvanic connection. When in baskets, if they make good contact without the bolts, that is sufficient, but the bolt makes the contact certain.

The use of zinc in this connection arose from the accidental leaving of a bar of zinc in a boiler which had just been cleaned.

and which at the end of the voyage was found to be entirely free from scale, while the zinc had disappeared.

Q. 303.—Would a fleet of war vessels on the Hudson River increase the weight on the roof of the Pennsylvania tunnel just beneath them or further down stream, and to what proportion of their weight? Over how much river bed would the weight of these vessels be spread? K. S.

A.—A fleet of war ships on the Hudson River immediately above the Pennsylvania tunnel, or at any other position in the neighborhood, would have no effect whatever upon the load pressing upon the roof of the tunnel. This is readily explained by the fact that each ship displaces or pushes aside an amount of water equal in weight to the weight of the ship, and that, therefore, the general level of the water in the river would not be increased by the presence of the warships therein, and so the pressure upon the tunnel, which will depend directly upon the depth of the water over the tunnel, would not be increased by the ships.

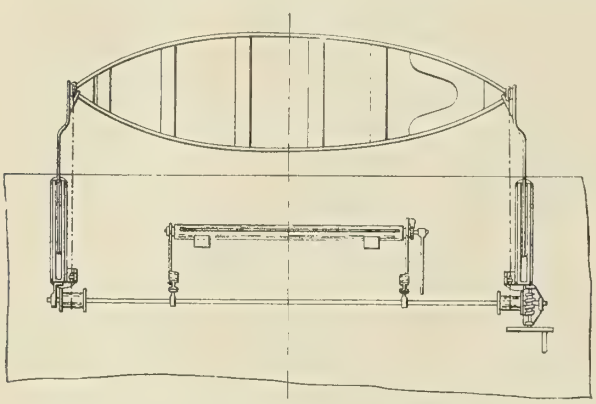
Q. 304.—At a recent examination a question was given as follows: A boiler 72 inches diameter with 80 pounds pressure; what is the stress per square inch on the longitudinal seam? Is this sufficient data for this problem, or should the length and the thickness of shell have been given? J. M.

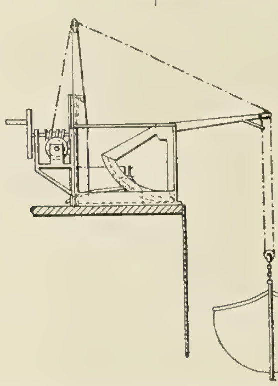
A.—The stress per square inch on the longitudinal seam of a cylindrical boiler is expressed by the formula $S = pd \div 2t$, where p represents the boiler pressure in pounds per square inch, d represents diameter of the boiler in inches, and t the thickness of the shell in inches. It will be seen that in order to obtain the stress in the example in question it will be necessary to know the thickness of the plate. Assuming the thickness to have been ½ inch, the stress figures out as 5,760 pounds per square inch.

SELECTED MARINE PATENTS.

795,937. APPARATUS FOR RAPID LAUNCHING OF LIFE-BOATS. GEORGE CHRISTIAN SCHMIDT, GOTEBORG, SWEDEN.

Claim.—3. In a device for rapidly launching life-boats, the combination with davit-arms adapted to oscillate in vertical planes, and provided at their outer ends with hoisting-ropes secured thereto, each passing around a block which is secured to and can be readily detached from the life-boat,

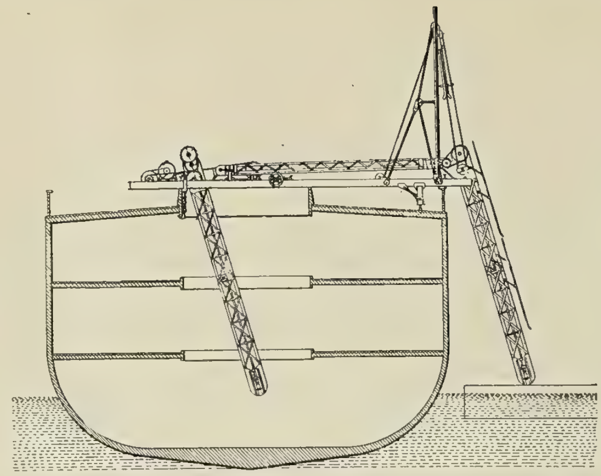




and then around blocks at the outer ends of the davit-arms, of forks projecting from the outer ends of the davit-arms and forming with the said davit-arms crutches, and of posts provided at their tops with pulleys, and two drums arranged on a rotatable shaft in common to both, for the purpose specified. Seven claims.

796,406. CARGO-CONVEYER. CHARLES H. ANDERSON, CHICAGO, ILL.

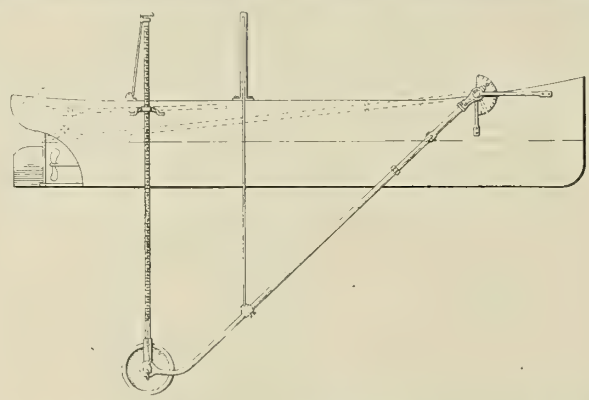
Abstract.—This invention relates to a cargo-conveyer devised more especially for loading packages of wood-pulp or the like into ships from wharves or lighters. In practice the conveyer mechanism when not in use is stored



upon a barge or dock. The barge or dock is provided with a derrick suitable for handing and placing the conveyer sections or members in position upon a ship and for removing the conveyer therefrom when it has done its work. The principal features of novelty reside in a portable support for the conveyer-sections, with means for leveling it upon the deck of a ship, the support carrying the electric motor or other power mechanism for operating the package-conveyers and having means in combination for holding the conveyer-sections in mutually co-operating relation during the rocking movement, etc., of the ship. Fifteen claims.

796,504. SOUNDING DEVICE. SWEPSON EARLE, WASHINGTON, D. C.

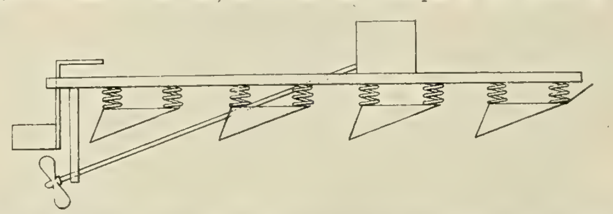
Claim.—2. A sounding device comprising a contacting member, an inclined pivoted arm carrying said member and having a rotary sleeve-joint, an in-



dicating device, a signal, an arm connecting signal and the contacting member, both indicating device and signal being actuated by the movement of the contacting member. Twelve claims.

796,846. RAFT OR OTHER CRAFT. CHARLES A. DE LAMBERT, VERSAILLES, FRANCE.

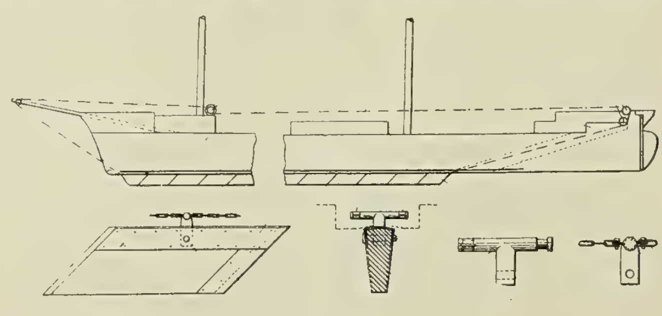
Claim.—In a raft or other flat-bottom craft having motive power, a plurality of floats of prismatic form with their axes perpendicular to the longitudinal axes of the raft, and lower faces oblique to the bottom of the



raft, and yieldable members for connecting said floats to the floor of the raft. One claim.

797,146. SECTIONAL CENTERBOARD FOR VESSELS. VIGGO L. OGIDINSSEN, SAN FRANCISCO, CAL.

Claim.—7. The combination with a vessel, of guides on the bottom thereof and running fore-and-aft, a centerboard movable in said guides, and means operatable on the vessel to shift the position of the centerboard in said guides or to remove it entirely from the bottom of the vessel or to replace it in position there-beneath. Eleven claims.



Marine Engineering

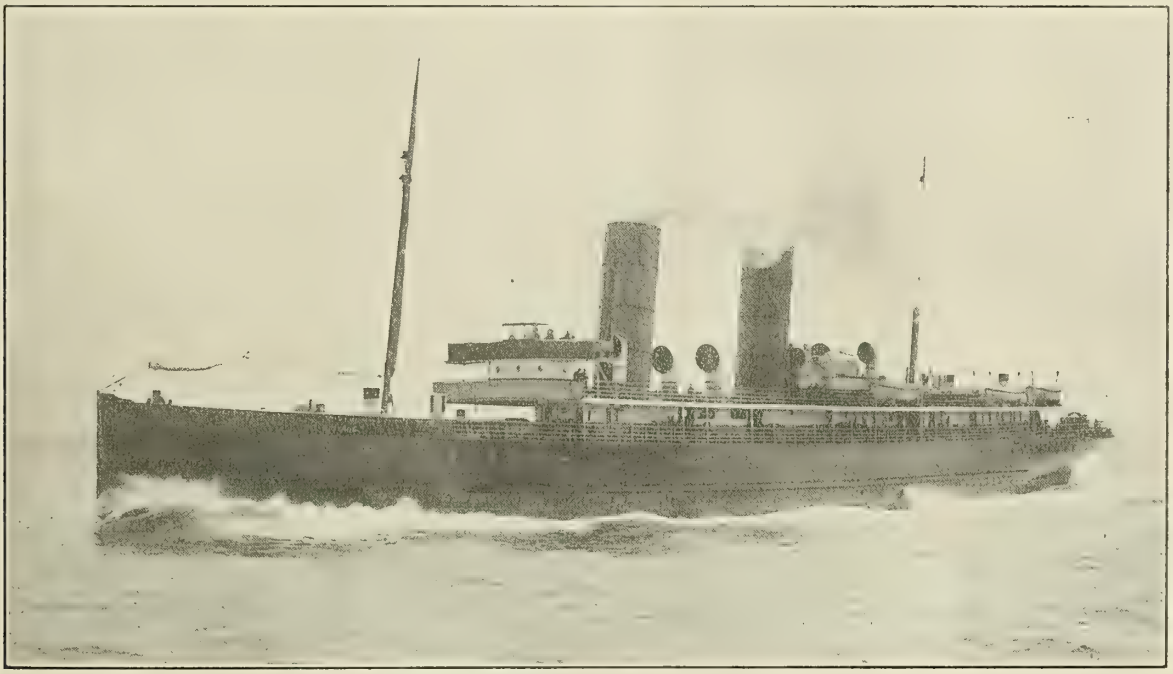
NOVEMBER, 1905.

THE TURBINE-DRIVEN STEAMER VIKING.

BY. L. RAMAKERS.

The *Viking*, now just in service, is the first Channel steamer to run from Liverpool with turbine machinery. She was built at the Low Walker yard of Messrs. Sir W. G. Armstrong, Whitworth & Company. We present a longitudinal section of the ship, and a view showing the vessel steaming at 23½ knots, which is the highest speed yet realized by a turbine-driven merchant steamer. The other illustrations will enable the reader to appreciate the interesting character of the ship, and the general excellence of the decoration.

large number of passengers—nearly 2,000—and to afford them ample accommodation in the way of promenade space, together with extensive facilities for refreshment in the shape of dining saloons. Her shelter deck extends uninterruptedly from stem to stern, a length of 361 feet, and above it is a big promenade deck, about two-thirds this length, which is carried out to the ship's sides, and is thus 42 feet wide at its broadest point. The first-class accommodation is aft and the second-class forward, the middle part of the ship being mainly occupied by the boilers and



THE NEW TURBINE STEAMER VIKING, ON TRIAL TRIP.

The dimensions are:

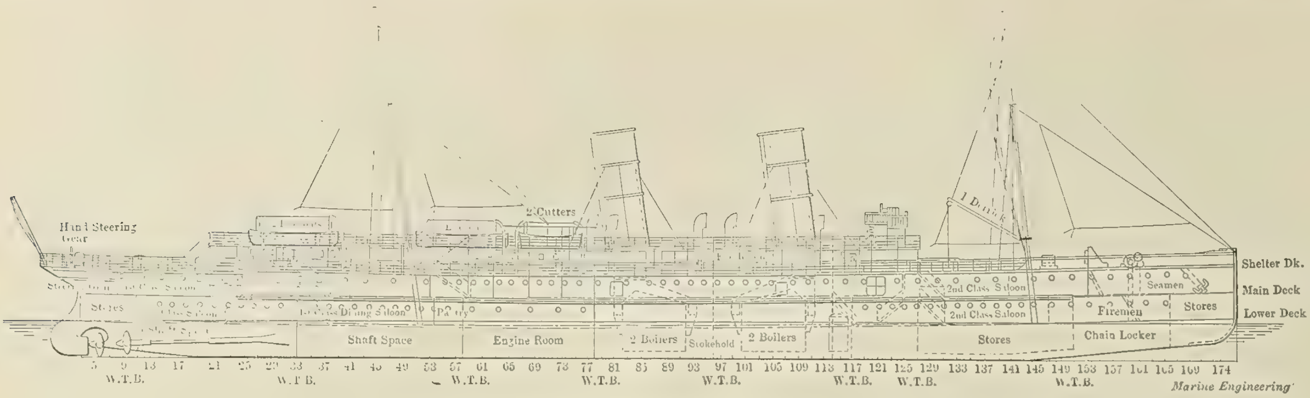
Length over all	361 feet
Length between perpendiculars	350 feet
Breadth	42 feet
Depth to upper deck	17 feet 3 inches
Depth to shelter deck	25 feet 3 inches

The subdivision of the vessel into watertight compartments has received special attention, and the principle has been carried so far that the ship will float with any two compartments full of water. The vessel has been built to Lloyd's requirements, and to conform with all the rules of the Board of Trade for a passenger certificate. She should be able to perform the crossing in three hours, and therefore it may be found possible for her to make two double trips every day in daylight. To meet the special requirements of this trade, she is designed to carry a very

engine room. The main, upper, and shelter decks are continuous, except in way of the engine and boiler rooms. Abaft the main entrance hall on the shelter deck there are four private cabins and a tea room, close to which there are two of the companion ladders leading to the promenade deck above.

The main saloon is the full width of the vessel, and is lighted by skylight and large rectangular windows at the sides. The woodwork is in dark oak, and a series of black and white reproductions of famous pictures, by well-known artists, forms a pleasing contrast with the dark tones of the somewhat severe paneling, which is also broken by the deep-set window openings and relieved by a simple carved design. The entrance hall is paneled in oak of the same tone as the main saloon, combined with blue and white Dutch tiles.

The ladies' room is entered through folding doors on the port side of the main saloon. It is paneled in sycamore in simple



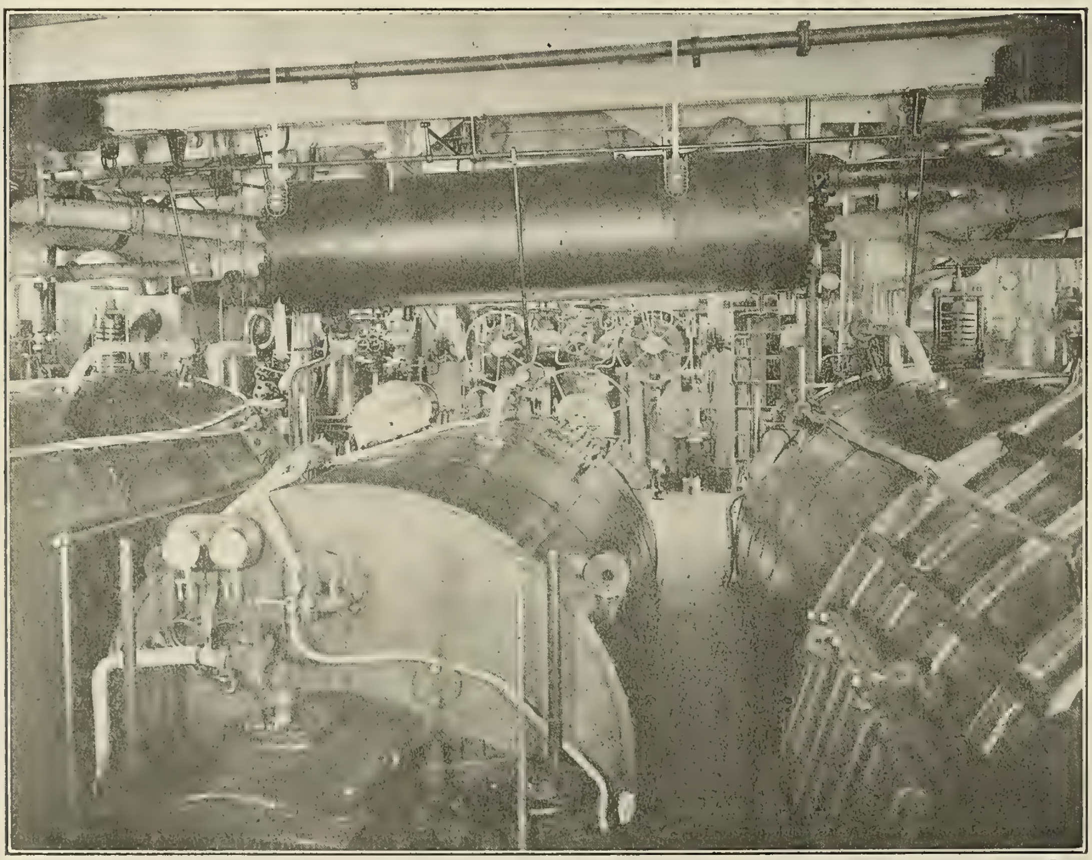
INBOARD PROFILE OF NEW TURBINE STEAMER VIKING.

style, and is lighted by large windows in the ship's side, and by the large light and air trunk, which leads to the dining saloon on the deck below. A large lavatory opens off the ladies' room. At the after end of the main saloon a stairway leads down into another saloon, where accommodation is provided for those who wish to lie down.

The dining saloon is entered by means of a stairway alongside the main entrance to the saloon. It provides seating accommodation for about 100 people, and is decorated with oak paneling. The usual pantry arrangements, with hot plates, lift to the galley, etc., are provided, and all the accessories required to make the service in this department as expeditious as possible. The first-class smoking room is on the shelter deck, and is entered by [illegible] placed just forward of the stairway from the shelter to the upper deck.

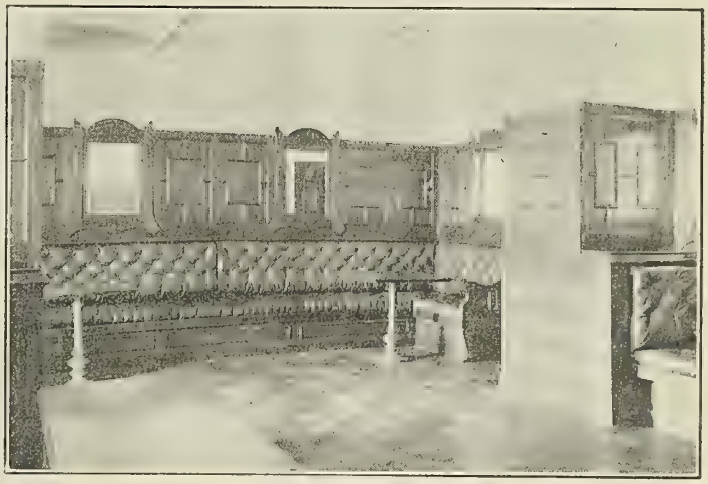
The second-class accommodation is at the forward end of the vessel, and consists of two large general saloons, one of which is arranged for dining, and a ladies' saloon. Lavatory accommodation is provided in convenient places throughout the vessel.

The propelling machinery consists of three sets of turbines manufactured by the Parsons Marine Steam Turbine Company. We give a view of the engine room, looking forward, with the high-pressure turbine in the center; one looking toward the starboard, looking aft; and one showing the starting platform, with all the steam-control wheels. The high-pressure turbine is in the center, with a low-pressure turbine on each side. The surface condensers are in the wings at the after end of the engine room, with the centrifugal circulating pump close alongside them. Two large independent air pumps are fitted conveniently near the condenser, and discharge into a large feed tank, whence the feed water is led to the automatic float-control tank, and so to the two feed pumps. These pumps discharge to the boilers direct, or through an exhaust feed heater on Parsons' patent, which gave very satisfactory results on the trials. The Parsons' patent

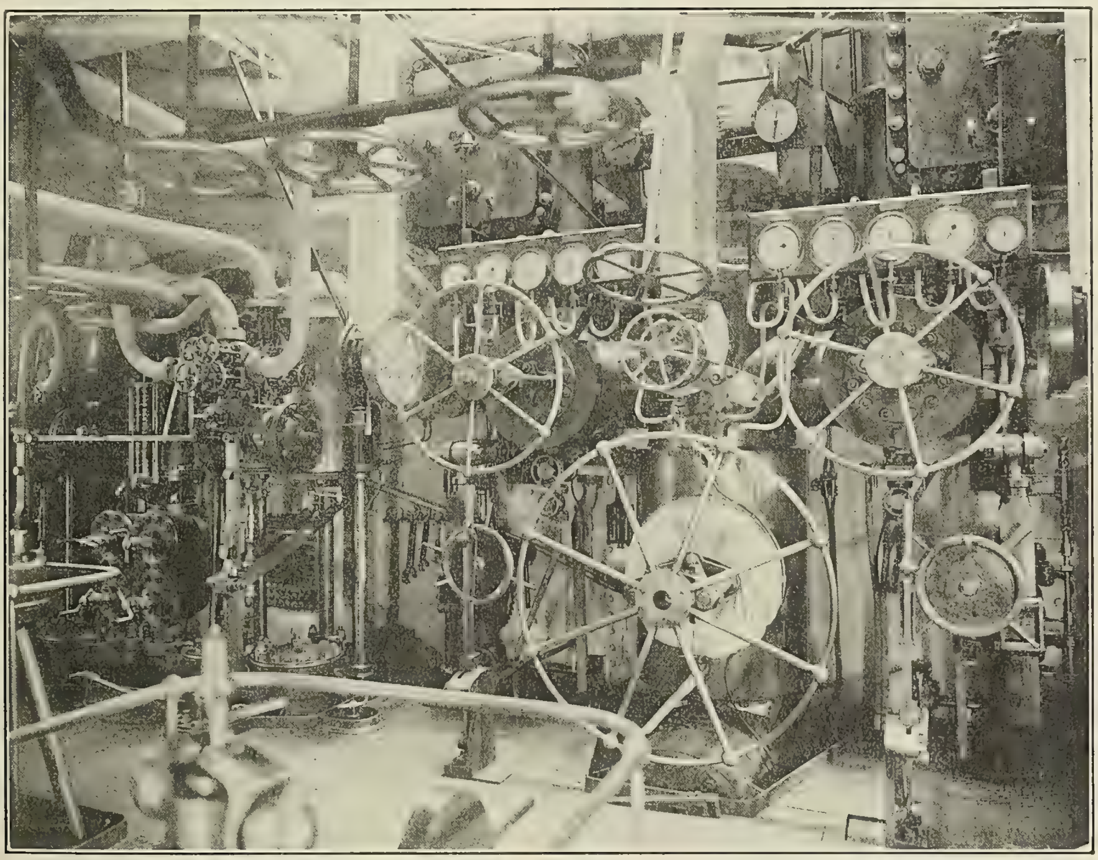


ENGINE ROOM, LOOKING FORWARD, WITH HIGH-PRESSURE TURBINE IN CENTER.


MAIN SALOON ON THE VIKING.


THE SMOKING SALOON.

vacuum augmenter is fitted in connection with the main condenser, enabling a high vacuum to be maintained. The lubrication of the bearings is effected by means of an oil circulating pump, which drives the oil under considerable pressure through all the bearings, and into a cooling and filtering apparatus on its way back to the pump. The stern-way turbines are arranged as usual within the low-pressure casings, and revolve idly *in vacuo* while the vessel is steaming ahead. The three shafts are of Armstrong-Whitworth Openshaw steel, and the propellers of a special bronze mixture worked up to a highly-polished surface. Steam of 160 pounds pressure is supplied by four double-ended boilers, 15 feet in diameter and 19 feet 6 inches long, placed in two boiler rooms separated by a watertight bulkhead. The stokeholds are arranged for forced draft, and the air is supplied by four fans placed in a separate compartment on the shelter deck and communicating with the stokeholds by means of straight air trunks. An emergency exit from each boiler room is arranged through the air lock into the fan room. The funnels are fitted with outer casings which are utilized as up-cast ventilators, and for this purpose are connected to compartments in various parts of the ship. A spark arrester is fitted in each funnel. The result of its trial was most satisfactory, as there was no sign of sparks or cinders when running at the maximum speed.


STARTING PLATFORM OF VIKING, WITH STEAM CONTROLLING WHEELS.

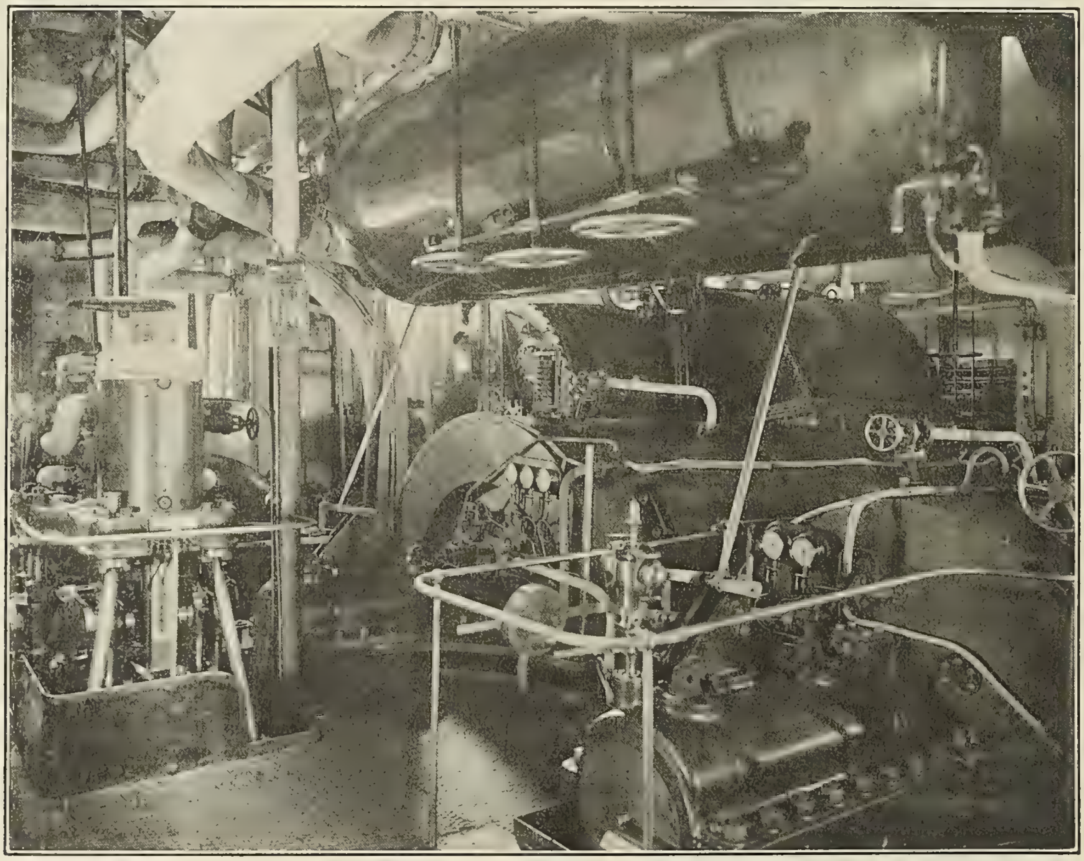
Two sets of trials were carried out besides the builder's preliminary test. The first official trial took place over the measured mile off the mouth of the Tyne, under somwhat unfavorable

THE LADIES' PARLOR.

DINING SALOON OF THE VIKING.

weather conditions. There was a fresh northwesterly breeze and some sea. The air pressure in the stokeholds did not exceed ¾-inch water column, and no attempt was made to develop the maximum power of the boilers. On June 14, the vessel was taken to sea for an extended trial. A course was set from Souter Point to Flamborough Head, 68.277 nautical miles, and the distance was traversed in both directions, care being taken to eliminate, as far as possible, the effect of the tide. The southward run was made at a speed of 23.684 knots, and the northward at 23.375 knots, or a mean speed over the whole distance of 23.53 knots. The vessel was kept at full speed for nearly seven hours. Although the power developed on this trial was higher than on the preliminary trials, there was very considerable reserve in the boilers.

The maneuvring qualities of the ship are very favorable, the turning circle of the vessel at 20 knots speed, with an angle of helm of 38 degrees, was made in 4½ minutes, the diameter of the circle having been 1,475 feet, or 4.2 lengths, and the angle of heel of the ship 3 degrees. The observations were taken during a breeze; and, as the time was short, only one circle was made, with the results given.



ENGINE ROOM, LOOKING AFT AND TO THE STARBOARD.

G. Edward Smith, engineer and naval architect, Philadelphia, Pa., has formed a partnership with W. W. Robinson, under the firm name of Smith & Robinson, and opened offices at 605 Provident Building, Philadelphia, as naval architects, superintendents of construction and repair, etc. Both members of the firm have been connected with the engineering department of the Wm. Cramp & Sons' Ship and Engine Building Company.

THE MERCHANT MARINE.*

BY GEORGE W. DICKIE.

Before a congress representing the commercial interests of the western half of the United States and standing on the western edge of this great country, facing the Pacific Ocean, destined to be the stage on which will be enacted the great commercial development of the future, the subject I have been requested to present to you needs no apology for its introduction.

For the last twenty-five years or so, I have, from time to time, by speech when I found anyone willing to listen and by papers as far as I could find readers for them, endeavored to awaken a sentiment in this country in regard to ocean-borne commerce and its necessity to the future prosperity of the nation. To arouse a sentiment in this country that would result in practical measures for the revival of the merchant marine has been a difficult task, and has tired out many a vigorous advocate of the needs of our shipping; even events that when they were happening were expected to produce great results have not, as yet, had the desired effect. To illustrate this let me quote from an address delivered by me before a body of commercial men in the early part of 1899, showing what I had expected from the events then taking place: "In studying important naval events in which this country has played the leading part, and which will make this period figure largely in naval history, a great fact has impressed itself on my mind, a fact that, if I understand the meaning of these events that have been following each other in rapid succession during the last few months, is going to make a mighty and lasting impression on the immediate future of this country; and this fact is, that the sentiment of this country, relative to the necessity of being a great naval power, has undergone a marked change in the last few months, and that sentiment will assert itself in the councils of the nation with a force that will demand recognition. Who would have ventured to predict the sequence of events that have followed so close on the heels of that declaration, the object of which was to force Spain to free Cuba? and to accomplish this, the President was empowered to use the full force of the army and navy to compel the Spanish to vacate that island. Troops were moved from the west to the east to help in the invasion of Cuba. The battleship *Oregon,* that we had just built to guard the Pacific coast, the only battleship that we had on the Pacific Ocean, was ordered to the Atlantic coast, not in the leisurely way in which battleships reach distant stations, but with few stops and the best economical speed she could make. Other battleships under the same necessity might have accomplished all that the *Oregon* has done, but the fact remains that up to this date (1899) the voyage of the *Oregon* stands alone at the head of ocean voyages made by battleships.

"This movement of troops and our battleship from this coast to the Atlantic was the first national move in the events of the war. While these orders were being carried out, who could have foreseen that the small Asiatic arm of our new navy should have struck such a blow to the Spanish power in Manila as to force a rearrangement of all the plans of the war, and render necessary a large military expedition to the other side of the world? This is somewhat different from ferrying troops to Cuba, and at once shows our weakness in merchant marine. This experience is to be the grand lesson of this war, and in the matter of ocean commerce the lesson will bring forth fruits in the near future. Then the gathering of many thousands of our young men from the middle states, where the sea and all its interests had no part in their daily life, and far less in their ideas of their country's place among the nations of the earth, and transporting them to the Pacific shore, there to board transport ships for the long ocean voyage to Manila, is to be an education to these men, taken as they are from every walk in life, that will bring the sea home to those states with such power as will forever dispel the apathy that has prevailed in the heart of this country for the last twenty-five years in regard to all matters affecting the ocean commerce of this great nation."

These hopes, expressed seven years ago, have not as yet been realized, though much work has been done by those who have the interests of our foreign commerce at heart; yet the outlook is not very bright. Hon. Charles H. Grosvenor, chairman of the congressional committee on the merchant marine, on June 1, writing to those who had been active in the work, says: "In the opinion of the best judges of these events, unless something is done by the next Congress at least, the hope of American shipping interests may as well be abandoned. If, with all the present information we have, Congress and the President will continue to ignore the just measures that have been introduced and promoted by the friends of the American merchant marine, we may as well abandon all future contests and make the best terms with foreign shipping we can." This shows how tired those laboring in the cause of our merchant marine have become, and how much they need that the growing sentiment through the country in favor of a revival of our foreign shipping should be exerted with such force that Congress will not be able longer to withstand the demand for action.

It is self-evident that to any country like this, having an immense seaboard on the two great oceans of the world, great power, both naval and commercial, is a very desirable thing, yet the history and progress of this country shows that, in certain stages in the development of such a country, it is not a prime necessity.

In our earlier history, with the bulk of population centered on the Atlantic seaboard, and dependent on an interchange of products with the "mother" country and her colonies, the energies and accumulated wealth of the people naturally turned to the sea. Behind them were great forests of magnificent material with which to build ships and in front of them the ocean highway to all countries. With such opportunities this young and vigorous nation, in the early part of last century, found an extensive mercantile navy an absolute necessity to its development and growth in power.

The destruction of a portion of the shipping of this country during the civil war is often given as a reason for the rapid decline of the country's foreign shipping trade. It is quite natural to come to such a conclusion, because the civil war happened at the same time as this decline of American shipping, but its absurdity becomes apparent as soon as we think about it. All other properties destroyed during the war, that were needed for the future progress of the country, were replaced in better form than that destroyed. If a city like Chicago is destroyed by fire and the country needs a city in that place, it is restored, grander and better fitted for all purposes than that which was burned. It is so with every product of man's labor, so long as the thing is needed and the man's ability to produce it is not destroyed, anything that destroys or takes away the tools he works with is an incentive for him to devise and produce better tools.

That the shipping interests of the United States did not recover from the injuries received during the civil war, but kept on steadily declining, is in itself an indication that a mercantile navy was not absolutely necessary to the prosperity and development of this country. Other causes operating at the same time, and in conjunction with the destruction of these properties, became powerful factors in preventing a prompt restoration of all ships destroyed.

One of these was the change, then taking place, in the material for the building of ships. The native oak of old England that had enabled her flag to "Brave a thousand years the battle and the breeze," was becoming a very scarce article, and ships being an absolute necessity to her power and position among the nations, a new material must be found out of which to build ships. This new material, iron, had gradually been gaining the confidence of those "who go down to the sea in ships and do business in great waters," and while privateers were burning the best wooden ships that carried the stars and stripes, the British shipyards were learning the most economical methods whereby iron plates and bars could be put into ship shape to carry freight, and not only equal

*Address before the Trans-Mississippi Commercial Congress, sixteenth annual session, Portland, Ore., August, 1905.

the wooden walls in strength and power to carry, but to far excel the best the shipbuilder's art could do in wood. In this new material Great Britain saw her opportunity to not only maintain her position on the sea, but to extend it to a magnitude that has become one of the wonders of the age.

The American shipbuilder and shipowner could see all this going on, and no doubt understood how it would end; but to his country shipbuilding and ship owning were not a national necessity in the same sense as it was to Britain. The necessity was a personal one and not national on the American side, while the position of Great Britain among the nations depends upon her naval supremacy. Hence the British shipbuilder had only to learn his business of building good ships and the government would see that the shipowner did not lack encouragement to use them.

With us, the men who could handle great enterprises were driven from the sea to make great highways for commerce on land. There was a continent to open up, stretching from the great lakes to the Pacific Ocean, and for the United States at that time this was a greater necessity than learning to build ships in iron and steel. So the generation now active in the affairs of this great country is purely and solely a railroad generation; that is to say, the leaders in enterprise among our business people, as a rule, whether in finance or commerce, have been trained to regard the development of railways as the one great and all-absorbing field of enterprise in this country. All other necessities for the best development of the country have been made subordinate to this. Perhaps at no other time in the history of the development of any country has one generation absorbed and brought under the power of civilization such a vast territory as has the present generation in the United States.

To men who could finance such enterprises, the best returns ever received from shipowning were not worth looking at, and, while the wealth of the old world was being scattered through the country for materials and labor to build railroads, where was the necessity for fostering a business that required a new kind of training, and did not present anything like the same opportunities for the getting of wealth?

Thoughtful men, however, throughout the country, especially in states facing the oceans, have been feeling for some time that a change was approaching, and that the time is not far off when this country will find it necessary, even at some cost, to build up an ocean commerce through ships under her own flag. As American wealth increases it must find an outlet on the ocean and our government must find a way to make it profitable to do so, by placing her shipowners on an equal footing with those of other nations with whom they must compete. Look at any railroad map of the United States and note the tangled network of black lines crossing and recrossing it in every direction and you will be forced to the conclusion that, in our generation at least, there is not much room left for more railroads, at any rate not for any more great trunk lines such as have been built in the last forty years, some of them spanning the entire continent.

The British government never permits an opportunity for cultivating a healthy sentiment on the part of the general public in regard to naval matters to slip by unimproved. Maritime exhibitions are fostered at the principal seaports. Naval maneuvers are carried on along her whole coast. Launches and trials are made semi-public functions. All the traditions of the past glories of the naval and mercantile fleets of Britain are made part of the education of the youth, and the desire to increase the glory of future fleets is carefully instilled into the coming generation, until it has become a part of the national life. No matter what the programme may be for the increase of the British Navy or the advancement of the mercantile marine, the country responds heartily. If we felt the necessity for naval power as Britain feels it, nothing could prevent its realization. Every country to-day that aspires to a leading place among the nations feels the necessity for securing, no matter at what cost, a position on the sea commensurate with the position aspired to in the council of nations. The development of the great coast lines of America, the necessity of providing industrial opportunities for the population of the cities and states bordering on the ocean, are questions that are pressing now for a solution, and this pressure will increase until it commands attention.

No industry equals shipbuilding in the amount of work it provides for large numbers of men. The shipyard of which I was until lately manager, not a very large one when compared with the great yards in the centers of shipping interests, maintains, through its direct employment of between three and four thousand men, a population of at least fourteen thousand. Into no other product of man's skill does such a large proportion of the money expended go for wages. That is one reason why shipbuilding centers are so generally prosperous. The shipbuilder may fail to get rich personally, and generally does, but as long as he builds ships he never fails to scatter wealth all around. The pity is that so few of them succeed in holding on to a small portion for themselves. The shipbuilder's art, and the art of making wealth, are hardly ever found in the same individual. It has often been said of my own family that "they would rather build ships and remain poor, than do anything else and grow rich."

When the necessity of having our flag represented in the commerce of the world in proportion to the wealth of the country becomes a general sentiment among the people, obstructive laws will be swept away, and wise laws, to carry such sentiment into effect, enacted. Till then, those who have this great question on their hearts must work and wait, using every opportunity that presents itself to impress upon others the necessity that they see and feel to be fast coming upon this country to assert itself as a power that means to take a fair share in the ruling of the wave.

If, then, the time is fast approaching when the United States, in a commercial sense, must give an affirmative answer to the question of the necessity of being a great power on the sea, is it the same in regard to the same question in a naval sense? Our country has already answered this question in the affirmative. The civil war has served to show in what direction the naval architect must look for the warship of the future. This knowledge, however, was for the benefit of British and French naval establishments, and not for the country that had so dearly bought the experience. The government had greater and more pressing necessities to provide for than the reconstruction of a navy. The whole edifice of government had been shattered, and must be rebuilt almost from the very foundations. Among the many necessities of the time a modern navy was not by any means the most needed, so the Navy Department fell out of sight of the people; they had so many other things to look at that were nearer home. For about twenty years the people of the United States knew nothing about their navy, and did not appear to care whether there was a navy or not. During these years a revolution, based partly on what had been learned from this country's experiences, had taken place in the navies of the world. The warship, like the merchant ship, was being built of new materials, and a race was being run between steel protection and gun penetration. Modern machinery was increasing the speed for short distances, as well as the ability to run long distances. When at last the American people, about eighteen years ago, began to feel that a navy was a necessity, if we were to be secure at home or honored abroad, the Navy Department, or what was left of it, which was very little, had to begin what was practically a new business. What other nations had reached through twenty years of experiment must be mastered at once by the United States naval architect, for this people have never been tolerant in regard to mistakes, as we know to our cost. With the growth of experience in the British and European naval centers had grown up great plants for handling the raw material required, and skill in operating them, so that the result could be depended upon. With us, such plants were expected to be brought into existence and perfect operation without passing through the experimental stage, and the result be not only equal to the best produced hitherto, but better in every particular. How the engineers and naval architects of this country responded to this sudden demand upon their abilities, both in design and execution, has been the admiration of naval experts the world over.

Eighteen years ago our naval architects and shipbuilders were twenty years behind those of Great Britain. To-day we are abreast of the most advanced practice in warship construction. The progress made toward providing this country with an effective, powerful, and in every way modern navy has been very satisfactory, and the Navy Department, with its splendid staff of naval architects and engineers, is quite able to meet the requirements of the future.

Thoughtful men sometimes wonder what we want with a navy when we have no merchant marine whose interests it is the duty of the navy to protect. It is a matter of universal knowledge, and I think almost universal regret, that our deep-sea shipping is practically driven from the ocean, more than 90 percent of our foreign commerce being carried in foreign ships flying foreign flags. In order that the United States may participate in ocean commerce to the extent to which her own imports and exports entitle her, there must be, first, a strong sentiment throughout the country in favor of carrying the products of our industry under our own flag to every country that cares to exchange products with us; second, wise national laws to foster and protect our merchant marine, making it possible for our shipbuilders to construct and equip ships and our shipowners to purchase and operate them; third, state and municipal laws, on the part of sea-girt states and maritime cities, encouraging shipbuilding and shipowning within their own borders. I have already spoken of the need of a general sentiment throughout our country in favor of a revival of the merchant marine. Now what has been done in regard to securing wise national legislation looking to the revival of American shipping for foreign commerce? The President in his annual message to Congress, December 7, 1903, said: "A majority of our people desire that steps be taken in the interests of American shipping so that we may once more resume our former position in the ocean carrying trade. But hitherto the differences of opinion as to the proper methods of reaching this end have been so wide that it has proved impossible to secure the adoption of any particular scheme. Having in view these facts, I recommend that the Congress direct the Secretary of the Navy, the Postmaster General, and the Secretary of Commerce and Labor, associated with such a representation from the Senate and House of Representatives as the Congress in its wisdom may designate, to serve as a commission for the purpose of investigating and reporting to Congress at its next session what legislation is desirable or necessary for the development of the American merchant marine and American commerce." In response to this earnest recommendation Congress passed the act of April 28, 1904, creating the Merchant Marine Commission, composed of five senators and five representatives. The mercantile interests of the country welcomed the investigation, and readily appeared before the commission to give testimony. The commission held meetings and took evidence in New York, Philadelphia, Baltimore, Boston, Galveston, New Orleans, Pensacola, Brunswick, Newport News, Chicago, Detroit, Cleveland, Milwaukee, Seattle, Tacoma, Portland, and San Francisco. The commission also held daily sessions in the city of Washington from November 22 to December 12, 1904, hearing evidence, sifting the printed testimony, and preparing the bill that is now pending. The testimony given before this commission, now published in three volumes, is a remarkable mass of evidence, with much difference in opinion as to methods and policies, but nowhere is there any difference as to the main principle of national recognition and encouragement of our hard-pressed ocean carrying trade. Of the hundreds of witnesses that appeared before the commission, a large proportion were men who have not a dollar's worth of actual interests in ships or shipbuilding, showing that the people are now really interested in the possible revival of our merchant marine. The report of the commission, largely explanatory of the bill introduced by them, should be carefully read by every one interested in the revival of our foreign commerce. The bill itself is a compromise measure; very few will find it entirely satisfactory in all its provisions; there are many conflicting interests that must be considered, and the result of the labor of the commission, as embodied in this bill, should receive the hearty support of all who desire to foster the upbuilding of our merchant marine.

Natural conditions, over which our shipowners and shipbuilders have no control, make the cost of building vessels in the United States much greater (from 30 to 40 percent at least) than the cost of building vessels in other countries. The cost of manning and victualling American-built ships is also much greater, probably not less than 30 percent, than it is in foreign ships. In addition to this there are other expenses in the management of vessels which are greater in the United States than they are in other countries, such as taxes, repairs, outfit, and equipment. Most of these higher costs are the outgrowth of conditions resulting from the policy of high protection that has obtained in the United States during practically the same period that American shipping engaged in the foreign trade has been declining.

The cost of materials entering into the construction and outfitting of American vessels is necessarily higher because of the conditions that obtain in other industries that are highly prosperous under the protection afforded by the tariff—industries employing precisely the same materials that are employed in shipbuilding and outfitting. The wages of the workmen employed at our shipyards are on the same high scale, due to the general standard of wages prevailing in similar industries, great, powerful, and profitable under a protective system that covers everything but the ship engaged in foreign trade. Let me give you a comparison I made in 1900, when visiting shipyards abroad, of the actual wages paid per week in the Union Iron Works shipyard, San Francisco, with the average weekly wages paid to the same class of workmen in twelve of the principal yards in Great Britain:*

	U. I. W.	BRITISH.
Drafting room: draftsmen	$19.44	$9.24
apprentices	6.30	3.10
Pattern shop: pattern makers	22.74	9.75
helpers	13.20	6.25
apprentices	6.07	3.02
Blacksmith shop: blacksmiths	20.28	9.84
helpers	13.20	6.62
apprentices	6.72	3.78
Machine shop: machinists	19.38	9.69
helpers	13.20	6.86
apprentices	5.58	3.05
Boiler shop: laying-out men	20.28	10.00
boiler makers	19.74	9.36
apprentices	7.08	3.22
Joiner shop: joiners	21.18	9.50
helpers	12.72	6.35
apprentices	7.08	3.22
Ship carpenters and calkers	22.14	9.88
helpers	13.20	6.22
apprentices	5.76	3.32
Ship fitters: fitters	20.10	9.50
helpers	12.60	6.52
apprentices	7.25	3.67
Riveters	21.50	9.88
rivet-heater boys	7.80	4.20
Drillers, chippers, and calkers	18.34	8.98
helpers	13.28	6.72
Coppersmiths	19.20	9.72
helpers	13.44	7.36
boys	7.20	3.86

While these conditions continue to exist it is futile to suggest, as has been done, that ships can be built in the United States as

*In only eleven of the thirty cases cited does the American wage fall below *double* the British; in only five cases is the excess less than 90 percent; in no case is it under 70 percent in excess.—THE EDITOR.

cheaply as abroad. The mere fact that they are not built at all indicates that their cost renders them unprofitable in comparison with foreign vessels. Even if other nations did none of the things that they have so long done, for the encouragement and maintenance of their merchant shipping, the difference in cost of constructing, operating, etc., between American and foreign vessels, would suffice to make it unprofitable, and hence unattractive, to Americans either to invest in or to build ships for the foreign trade. But when we add to these undeniable advantages which foreign competitors possess over our own citizens, the advantage which they also possess through government assistance and regulation, then the reason why our American vessels carry but 9 percent of a foreign commerce valued at about $2,500,000.000 annually, and why foreign vessels carry over 90 percent of this commerce, receiving therefor freight charges closely approximating two hundred millions of dollars, are pretty well explained and set forth. These are the conditions that Congress must recognize and adequately meet through the adoption of effective legislation, before the problem of establishing an American merchant marine in the foreign trade, measurably equal to our foreign carrying needs, has been solved. I have faith in the ability of Congress to solve the problem of how best to revive and maintain the merchant marine in this country. The work done by the present commission has thrown much light on what was obscure in the problem, and the long-suffering shipbuilder and shipowner will yet see what he has so long looked for—business that if well done will bring satisfactory compensation.

Whatever expenditures the government may have to make in order to build up our merchant marine will be a good investment for the nation. We are spending on our new navy over $80,000,000 annually, and without a corresponding merchant fleet to depend on for service in time of need the war fleet's power may be very much weakened. During the Spanish war the United States was hard pressed for merchant steamers to carry men and materials; we had to buy freight ships at any price that was asked, and this war was a small thing for this great country; yet the lesson taught in this respect has passed unheeded. During the war between Japan and China the former had no merchant ships of her own to depend on; she had to hire or buy whatever she could get, but the experience was not lost. After the war she determined to have a merchant marine of her own, and set about bringing it into existence, the government helping the shipbuilder and shipowner to the extent necessary to effect the desired result. When the time came to try her strength against that of Russia, she had at least fifty large ocean steamers of her own, ready at once for the work, enabling her to strike a quick and decisive blow at the Russian, who was dreaming that it would take the Jap a long time to get ready. She had transports all ready to send with her army as soon as war was declared. Her investment in a merchant marine was a paying one. We will soon see a still further expansion of the merchant marine of Japan. No nation can be a great sea power without a great merchant marine, giving a reserve of both ships and men in time of need.

Besides the aid that must come from national legislation, I have always maintained that the sea-bordered states will be forced to apply state legislation to the upbuilding of their own shipping interests. The state can foster shipping just as effectively as the nation, as the benefits to be derived from large shipping interests will center in the shipowning and shipbuilding states. For instance, to every ship built and owned in the state in which she is enrolled, the harbors of the state ought to be free, and all shipping property, when engaged in inter-state or foreign commerce, should be relieved of all state or municipal taxes. Some states have done this, to a limited extent, and these states own whatever ocean trade this country possesses to-day. The eyes of the people of this country are being opened to the importance of naval power, both in a military and commercial sense; also to the future position we are destined to occupy among the great nations of the world. One thing is certain, we have entered on a course that is to lead us, if not into deep water, at least on to deep water, and on deep water we will be much safer in our own ships.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, report under date of October 10, 1905, the following percentage of completion of vessels building for the United States Navy:

			Sept. 1	Oct. 1.
BATTLESHIPS.				
Virginia	19 knots.	Newport News Co	92.89	94.24
Nebraska	19 "	Moran Brothers Co	79 58	81.
Georgia	19 "	Bath Iron Works	86.44	87.44
New Jersey	19 "	Fore River Shipbuilding Co	89.3	90.1
Rhode Island	19 "	Fore River Shipbuilding Co	93.	93.7
Connecticut	18 "	Navy Yard, New York, N. Y	86.15	89.39
Louisiana	18 "	Newport News Co	86.4	87.73
Vermont	18 "	Fore River Shipbuilding Co	61.4	63.8
Kansas	18 "	New York Shipbuilding Co	60.1	62.7
Minnesota	18 "	Newport News Co	71.16	73.86
Mississippi	17 "	Wm. Cramp and Sons	38.71	40.87
Idaho	17 "	Wm. Cramp and Sons	33.66	36.22
New Hampshire	18 "	New York Shipbuilding Co	18.2	20.4
ARMORED CRUISERS.				
California	22 knots.	Union Iron Works	81.8	82.9
South Dakota	22 "	Union Iron Works	80.6	81.9
Tennessee	22 "	William Cramp and Sons	84.32	86.08
Washington	22 "	New York Shipbuilding Co	83.9	85.8
North Carolina	22 "	Newport News Co	14.96	19.2
Montana	22 "	Newport News Co	13.04	16.81
SEMI-ARMORED CRUISERS.				
St. Louis	22 knots.	Neafie and Levy Co	75.7	79.69
Milwaukee	22 "	Union Iron Works	80.6	82.
Charleston	22 "	Newport News Co	99.7	99.8
SCOUT CRUISERS.				
Chester	24 knots.	Bath Iron Works	0.	6.11
Birmingham	24 "	Fore River Shipbuilding Co	4.7	9.3
Salem	24 "	Fore River Shipbuilding Co	4 3	8.2
TRAINING SHIPS.				
Cumberland	Sails	Navy Yard, Boston	95.	95.
Intrepid	"	Navy Yard, Mare Island	97.5	97.5
TORPEDO BOATS.				
Goldsborough	30 knots.	Wolff and Zwicker	99.	99.
O'Brien	26 "	Lewis Nixon	99.	99.
SUBMARINE TORPEDO BOATS.				
Submarine No. 9	.....	Fore River Shipbuilding Co.	17.6	25.4
" " 10	.....	Fore River Shipbuilding Co	16.5	21.1
" " 11	.....	Fore River Shipbuilding Co	16.5	23.6
" " 12	.....	Fore River Shipbuilding Co	16.5	23.1

The Generating Sets of the Connecticut.

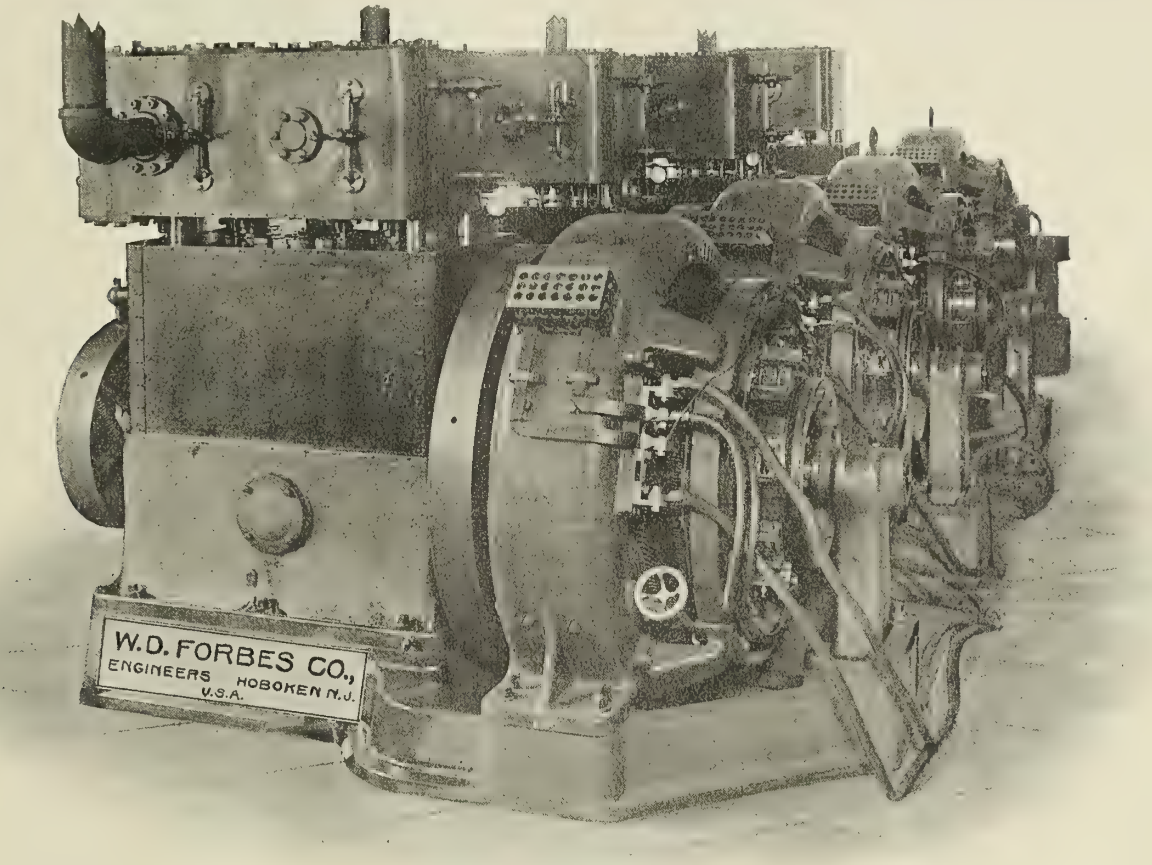
In the electric-light plants of the United States Navy the ordinary commercial conditions are departed from greatly. While it is the usual custom when furnishing an engine of a given power to guarantee that it will carry a certain overload for a certain time, the Bureau of Equipment of the Navy demands that the overload carried shall be 33⅓ percent above the rated capacity of the engine and generator, as of course these must go together.

For evident reasons a very condensed plant is to be considered, and weight is a matter of great importance. Coupled with these requirements is first-class governing, and the water consumption must be brought down on certain sizes to very low figures. The steam pressure is varied by dropping 20 percent below normal and by being carried 20 percent above. These conditions demand a special engine which can hardly be called commercial. In other words, the bureau has gone very closely to the limit of possibility, if it has not in some sizes of sets gone past it.

Other demands are also made, as for instance, in a compound engine the stroke must not exceed the diameter of the high-pressure cylinder. This is done with a view to preventing the oil which may be splashed on the piston rod from being carried into the cylinder and over to the condenser, and thence to the boiler, where it would do damage.

The oiling system is forced by means of a pump, but the manufacturers are not restricted as to what style of force system shall be employed. There are two forcing systems, one wherein the oil is passed from one bearing on to a second, and then on to a third, and even a fourth at times; the second, where the forced oil travels directly to each bearing independently. The first system is open to the serious objection that if the first bearing happens to be loose the oil does not reach the second bearing. In the second system this objection is entirely overcome.

The engines consist of compound units with cylinders measuring 10 and 20 inches respectively in diameter, and a stroke of 10 inches, and operate as above at a speed of 350 revolutions per minute. The steam pipe has a diameter of 3 inches and exhaust

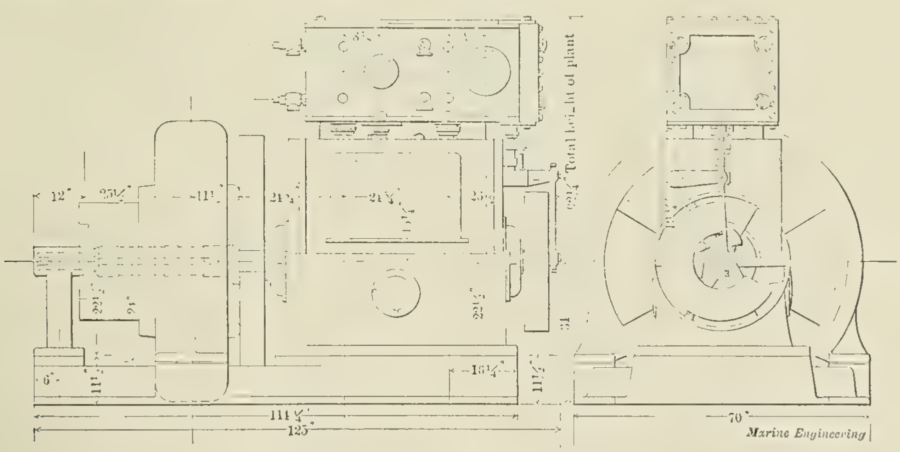


A GROUP OF FOUR GENERATING SETS FOR THE CONNECTICUT.

The Crocker-Wheeler Company, on obtaining the contract for supplying the *Connecticut* with her electric-light plants, made selection of the Forbes engine, which is built by the W. D. Forbes Company, in Hoboken, as an engine likely to meet the above requirements. In every respect the results of the tests already made have been highly satisfactory, and the engines have met all re-

pipe of 6 inches. The drawing shown herewith indicates that the entire length of each set over all is 10 feet 5 inches, while the length of the foundation is 9 feet 6¾ inches. The extreme width is 5 feet 10 inches, and the total height from bottom of foundation to top of cylinder-head studs is 7 feet 8¼ inches.

There are eight of these sets to be installed on the *Connecticut,*



THE GENERAL LAYOUT OF ONE OF THE SETS.

quirements. In these engines the Right governor is used, and the revolutions (350) have never varied more than one revolution either up or down, when throwing off the overload or throwing it on. The generator also fills all the demands noted; and the battleship *Connecticut* will be equipped with the largest electric installation of any ship in our navy.

of which four are shown in the accompanying photograph. The total weight of each set without throttle and exhaust valves is 23,270 pounds, which figures out at 232.7 pounds per kilowatt normal output.

The generators of these sets are of the multipolar type, having eight poles of cast steel bolted to the frame. The frame is of cast iron with internally-projecting flanges, which insure ample stiffness and give a finished and pleasing appearance to the machine. The frame is split horizontally, the halves being accurately lined by dowel pins and held together by bolts.

The field winding is compound, with the shunt and series coils separate, with the very efficient cooling surface which is necessary to insure the cool running demanded of such sets.

The commutator spider is mounted on an extension of the armature spider in order to have it independent of the shaft. The commutator bars are of the highest grade of hard drawn copper, designed to give ample wearing depth. The surface of the commutator is very liberal and the brush density low. The core, winding, and commutator are thoroughly ventilated, which insures a uniformly low temperature throughout.

The sets possess very satisfactory commutation and compounding characteristics and in their mechanical construction and electrical behavior they come well within the government requirements. Each machine is connected to the engine by flange coupling and the two mounted on a common sub-base.

The Voyage of the Steamship Dakota from New York to Seattle.

Particulars relative to the maiden voyage of the Great Northern steamship *Dakota*,* built by the Eastern Shipbuilding Company, New London, Conn., will, no doubt, be of interest to maritime and engineering circles, on account of the size of the vessel, design, installation of water-tube boilers, and the length of voyage.

Only twelve of the sixteen boilers were used at the same time during the whole run, and the same engineering staff that had charge of her engine and boiler rooms during the speed-trial run off the coast of Virginia, in the month of April last, took her around to Seattle, Wash., and consisted of the following men: one chief engineer, one first assistant engineer, two second assistant engineers, two third assistant engineers, two fourth assistant engineers, three junior engineers, three electricians, two refrigerating engineers, one deck engineer, fifteen oilers, nine water tenders, thirty-six firemen, thirty coal passers, a total of 107 officers and men.

The start was made from the pier in New York at 1.30 P.M., April 28, 1905, and Sandy Hook passed at 3.40 P.M. The pilot was discharged at 4.30 P.M., and full speed ahead was commenced at 4.34 P.M. of the same day. The draft on leaving New York was 32 feet 2 inches forward, and 32 feet 4 inches aft, equal to a displacement of about 31,000 tons, with 5,044 tons of Pocahontas coal in the bunkers.

The electric steering gear was used during the whole run and has been pronounced by Capt. Emil Francke, the commander of the vessel, to have given entire satisfaction, and all connected with the vessel have words of praise for her seagoing qualities, and call the *Dakota* the best sea vessel they have ever been on.

The *Dakota* arrived at Coronel, Chile, at 7.05 A.M., May 28, 1905; the total distance steamed in 29 days 10 hours and 53 minutes was 8,778.1 nautical miles; average speed 12.32 knots; and the coal consumed during the voyage was 4,060 tons, making the coal remaining in bunkers 984 tons. The fresh water used during the run for boiler feed make-up was of an average of 32 tons per 24 hours, and total oil used for lubricating purposes was 1,500 gallons. The draft on arrival at Coronel was 27 feet 2 inches forward and 29 feet 4 inches aft. The induced-draft fans had been running continuously on the whole voyage, without giving the least trouble, and the mechanical stokers had done the same.

At Coronel, 3,163 tons of Schwager coal was put in her bunkers, and, while coaling, the engineers examined and adjusted the parts of machinery and boilers needing attention. At 12.40 P.M., on Saturday, June 3, the ship left Coronel for San Francisco. The pilot was discharged at 1.00 P.M., and full speed ahead commenced at 1.04 P.M. The draft on leaving Coronel was 29 feet 5 inches forward and 31 feet 6 inches aft, corresponding to a displacement of about 29,300 tons. It was soon discovered that the Chilean coal did not work very well in connection with the mechanical stokers, and considerable trouble was experienced with same.

Stopped for pilot at San Francisco at 11.00 A.M., June 20, and anchored at 12.25 P.M. The distance steamed in 17 days was 5,286.3 nautical miles; average speed, 12.92 knots; and the coal consumed during the voyage was 2,797 tons. The fresh water used for boiler feed make-up per 24 hours was about the same as on the run from New York to Coronel. The vessel was placed at dock in the afternoon of the day of arrival, and the discharging of cargo, consisting principally of steel rails, commenced the following day. In handling the cargo the electric deck winches gave excellent satisfaction.

While at San Francisco opportunity was taken to examine the different parts of the main engines and to make adjustments. Some of the main cylinders and valves were also looked at, and all found to be working up nicely to a good smooth surface.

At 4.40 P.M., June 24, the ship left San Francisco for Seattle, and full speed ahead was commenced at 6.01 P.M. of the same day. The *Dakota* arrived at Seattle about noon on June 27; the distance steamed in 2 days 18 hours and 11 minutes was 815 nautical miles; average speed 12.15 knots; and the coal consumed during this run was 510 tons.

On arrival at Seattle the mechanical stokers were entirely out of commission; they will be repaired at Seattle and given further trial with the coal they take on board at said port. Everything else was in first-class shape, and the ship could have started for sea again by the time she was coaled.

From the foregoing statement it will be seen that the *Dakota's* actual steaming time from New York to Seattle, a distance of 14,879.4 nautical miles, was 49 days, 5 hours, and 4 minutes, and during these long runs 7,367 tons of coal were consumed in her boilers.

The boilers throughout the whole trip worked excellently; small defects developed, principally with the brickwork in furnaces; but, as only twelve out of the sixteen boilers were in use at the same time, one of these spare boilers was lighted and cut in when necessary to clear and rectify any defects on any of the other boilers. This method was extensively used when the mechanical stoker boilers commenced to give trouble.

The maximum speed of the *Dakota* was reached on June 12, when she steamed 350.3 knots in 24 hours, consuming about 160 tons of coal. Average speed, 14.5 knots.

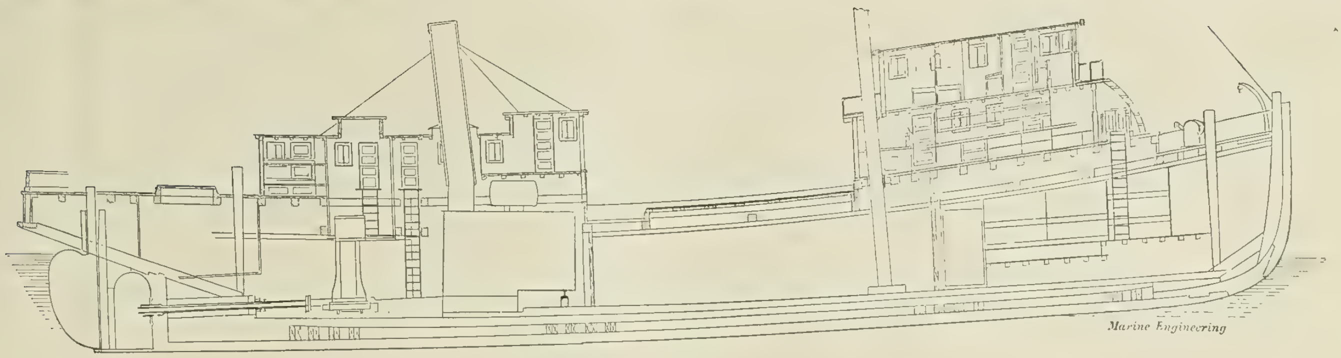
Much has been said and written about the battleship *Oregon's* run in 1898 from Puget Sound, Wash., to Jupiter Inlet, Fla., a distance of 14,510.9 nautical miles, which she made in 54 days, 3 hours, and 51 minutes, actual steaming time, and consuming 4,009.38 tons of coal during the whole run. The *Oregon's* greatest displacement during her long voyage was 11,857 tons, being only about one-third of the *Dakota's* displacement.

*For description of vessel and machinery, see Marine Engineering, June, 1905, page 248; and July, 1905, page 290.

The Fishing Steamer James M. Gifford.

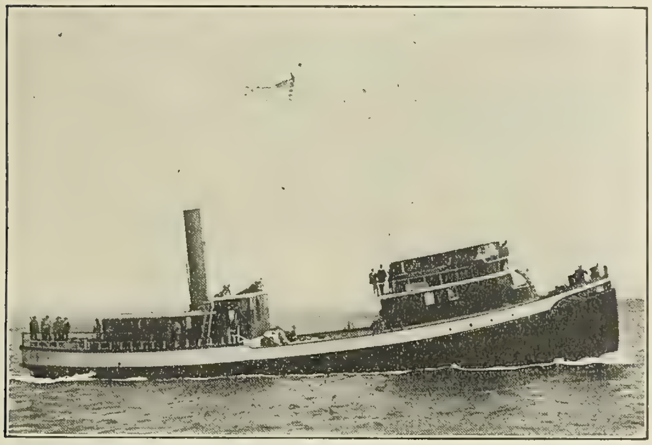
Built for the Fisheries Company, of New York, the *Gifford* has a length of 129 feet over all, a molded beam of 19 feet 3 inches, and a depth of 9 feet 6 inches. The framework of the hull, including keel, stem, stern post, and frames, is of white oak. Outside planking, ceiling, clamps, shelf, keels, deck beams, and deck are of yellow pine, while deckhouse and hatches are of white pine. The *Gifford* has a Trout propeller actuated by a simple engine with cylinder 20 by 20 inches, supplied with steam by a boiler 8 feet in diameter and 13 feet long. The engine is operated condensing, the surface condenser being from the works of Williamson Brothers, of Philadelphia.

The *Gifford* was built by the Greenport Basin and Construction Company, of Greenport, N. Y., under contract signed in January last, was launched April 15, and has recently been delivered.



INBOARD PROFILE OF FISHING STEAMER JAMES M. GIFFORD.

The boat was launched just thirty-nine days after the keel was laid. The trial trip occurred May 29, and the steamer was delivered to her owners the following day. She is designed to carry from 1,100 to 1,200 barrels of fish. We present a photograph of the steamer, together with an inboard profile, showing the general arrangement to be very similar to that of the steam trawlers operating in the North Sea, and illustrated on page 303 of MARINE ENGINEERING for July.



THE GIFFORD UNDER WAY.

USEFUL DATA OF SCOTCH MARINE ENGINEERING PRACTICE.

BY H. WILKES.

In marine engineering work the preponderance of experience has been on the other side of the water. The engineering world has grown beyond and little recognizes national boundaries, however, so that reciprocity in data and experience is now well-nigh universal. Every broad-minded engineer recognizes that the greater part of the valuable information in his private data book comes from the work of others, and in a measure should be available to his co-workers. The accompanying tables and diagrams are taken from the leaves of the writer's pocket-book, all the figures being based upon engines, boilers, and accessories actually constructed by Scotch and English marine-engine builders.

Table I gives the relative sizes of high, low, and intermediate cylinders of marine engines; and Table II general proportions

TABLE I.

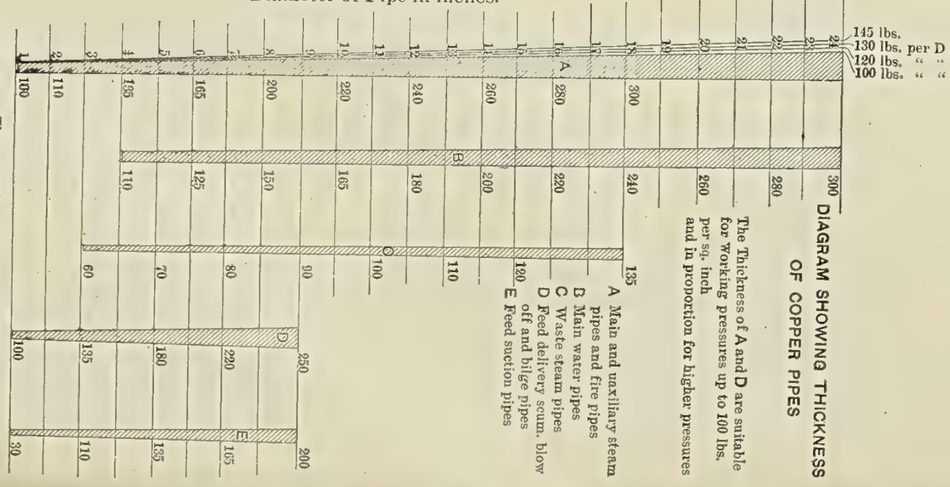
Cylinder Sizes with Ratios.			H. P. to M. P. = 1:2.8. H. P. to L. P. = 1:7.		
H. P.	M. P.	L. P.	H. P.	M. P.	L. P.
9	15	24	9½	15½	25
10	16½	26½	10½	17½	28
11	18	29	11½	19	30½
12	19½	31½	12½	20½	33
13	21½	34½	13½	22	35½
14	23	37	14½	24	38½
15	24½	39½	15½	25½	41
16	26½	42½	16½	27	43½
17	28	45	17½	29	48½
18	29	47½	18½	30½	49
19	31½	50	19½	32	51½
20	33	53	20½	34	54½
21	34½	55½	21½	35½	57
22	36	58	22½	37	59½
23	38	61	23½	38½	62
24	39½	63½	24½	40½	65
25	41	66	25½	42	67½
26	43	69	26½	43½	70
27	44½	71½	27½	45½	73
28	46	74	28½	47	75½
29	47½	76½	29½	48½	78
30	49½	79½	30½	50	80½
31	51	82	31½	52	83½
32	52½	84½	32½	53½	86
33	54½	87½	33½	55	88½
34	56	90	34½	57	91½
35	57½	92½	35½	58½	94
36	59	95	36½	60	96½
37	61	98	37½	61½	99
38	62½	100½	38½	63½	102
39	64	103	39½	65	104½
40	65½	105½	40½	66½	107

TABLE II.—I. H. P. OF BOILERS.

I. H. P. Per Cubic Foot.			Size of Boilers.			I. H. P. Per Cubic Foot.			Size of Boilers.		
.4	.45	.5	Diam.	Length	Volume.	.4	.45	.5	Diam.	Length.	Volume.
160	180	200	8′ 0″ 8′ 3″	7′ 11½″ 7′ 6″	400	600	675	750	14′ 3″ 14′ 6″	9′ 5″ 9′ 0″	1,500
200	225	250	8′ 9″ 9′ 0″	8′ 4″ 7′ 10½″	500	640	720	800	14′ 6″ 14′ 9″	9′ 7½″ 9′ 4½″	1,600
240	270	300	9′ 6″ 9′ 9″	8′ 6″ 8′ 0″	600	680	765	850	14′ 9″ 15′ 0″	9′ 11½″ 9′ 7¼″	1,700
280	315	350	10′ 3″ 10′ 6″	8′ 5″ 8′ 0″	700	720	810	900	15′ 0″ 15′ 3″	10′ 2¼″ 10′ 0″	1,800
320	360	400	11′ 0″ 11′ 3″	8′ 5″ 8′ 0″	800	760	855	950	15′ 3″ 15′ 6″	10′ 5″ 10′ 0″	1 900
360	405	450	11′ 6″ 11′ 9″	8′ 8″ 8′ 4″	900	800	900	1.000	15′ 9″ 16′ 0″	10′ 3″ 10′ 0″	2,000
400	450	500	12′ 0″ 12′ 3″	8′ 10¼″ 8′ 6″	1,000	840	945	1.050	16′ 0″ 16′ 3″	10′ 5½″ 10′ 1½″	2,100
440	495	550	12′ 6″ 12′ 9″	9′ 0″ 8′ 7½″	1,100	880	990	1,100	16′ 3″ 16′ 6″	10′ 7½″ 10′ 3″	2,200
480	540	600	13′ 0″ 13′ 3″	9′ 0″ 8′ 9″	1,200	920	1.035	1,150	16′ 6″ 16′ 9″	10′ 9″ 10′ 5¼″	2,300
520	585	650	13′ 6″ 13′ 9″	9′ 1″ 8′ 9½″	1,300	960	1.080	1.200	16′ 9″ 17′ 0″	10′ 10¾″ 10′ 7″	2,400
560	630	700	13′ 9″ 14′ 0″	9′ 6″ 9′ 1″	1,400	1,000	1,125	1,250	17′ 0″ 17′ 3″	11′ 0″ 10′ 8½″	2,500

TABLE IV.

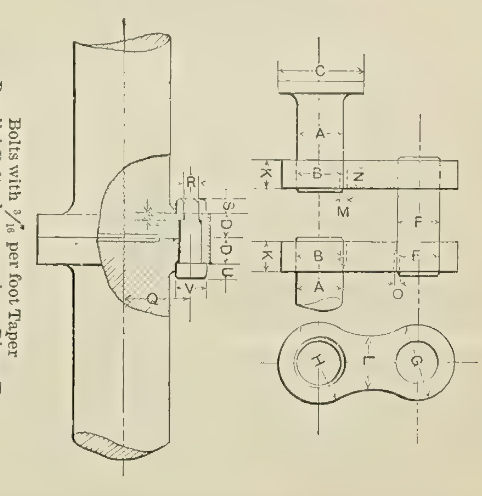
I. H. P. per Ton of Boiler.	Number of Engines.	Total Grate Surface. Sq. Ft.	Total Heating Surface. Sq. Ft.	Ratio of H. S. to G. S.	Boiler Pressure.	I. H. P.	I. H. P. per Square Foot of Grate Surface.	I. H. P. per Sq. Ft. of Heating Surface.	Grate Surface per I. H. P.	Heating Surface per I. H. P.	Number, Size of Boilers, and Length.	Number and Size of Furnaces.	Length of Grate Bar.	Total Number of Tubes, Diameter, and Length.	Thickness of Tubes, Common (B.W.G.), Stay (Inches). C. S.	Area through Tubes. Ft.	Ratio of G. S. to Tube Area.	Diameter and Height of Funnel.	Ratio of G. S. to Funnel Area.	Steam Space in Cubic Feet.	Cubic Feet of Do. per I H. P.	Cubic Feet of Boiler to One Sq. Ft. of H. S.	Net Weight of Boiler. Tons	Duration of I. H. P.	Weight of Water. Tons	H. S. to One Cubic Foot of Boiler.	Weight of Water and of Boiler per Cub. Ft. of Boiler. Lbs.	I. H. P. per Cubic Foot of Boiler.
22.14	138	117	4 174	35.7	160 / 160	1,583	13.53	.3792	.0739	2.635	2 D.E. 11′ 6″ × 15′ 6″	8 S.B. 3′ 3″	4′ 6″	752 × 3″ × 6′ 0″	8 × 5/16″	27.5	4.26	6′ 6″ × 54′ 0″	3.53	808	.510	.771	71.0	Mean of 2 runs on mile	37.5	1.297	26.0 / 49.7	.492
21.77	139	24.75	762	30.8	142.5 / 150	270	10.90	.3514	.0917	2.822	1 S.F. 9′ 6″ · 8′ 3″	2 S.B. 2′ 9″	4′ 6″	122 3¼″ 5′ 10½″	10 · ¼″	5.64	4.39	2′ 9″ · 26′ 2″	4.17	130	.481	.769	12.4	Mean of 2 runs on mile	7.85	1.303	30.05 / 47.5	.461
19.82	140	117	2 879	24.6	135 / 140	1 328	11.35	.4613	.0880	2.168	2 S.E. 13′ 0″ × 11′ 6″	6 S.B. 3′ 3″	6′ 0″	800 × 3¾″ × 7′ 6″	7 × 5/16″	17.7	6.61	5′ 6″ × 45′ 0″	4.93	680 / 795	.512 / .599	1.060	67.0	Mean of runs on 87 knots	38.0	0.943	27.77 / 49.1	.435
20.0	143	129.5	4 210	32.5	158.5 / 160	1,460	11.28	.3468	.08805	2.883	2 D.E. 12′ 0″ × 15′ 6″	8 S.B. 3′ 5″	4′ 9″	696 × 3¼″ × 6′ 1″	8 × 5/16″	30.0	4.32	7′ 0″ × 62′ 0″	3.37	814	.558	.832	73.0	Mean on mile	42.0	1.202	26.85 / 46.65	.446
21.77	141	193	5,142	26.6	157.5 / 160	2,046	10.60	.3979	.0943	2.513	2 D.E. 13′ 6″ × 16′ 0″	12 S.B. 3′ 2″	5′ 1″	728 × 3½″ × 6′ 6″	8 × 5/16″	36.0	5.36	7′ 6″ × 58′ 10″	4.37	1,108	.512	.891	94.0	Mean between lights	57.0	1.123	28.0 / 46.0	.446
21.13	144	220.5	6 170	28.8	150 / 150	2,430	11.02	.3939	.0908	2.539	2 D.E. 14′ 3″ × 18′ 0″	12 S.B. 3′ 6″	5′ 3″	808 × 3½″ × 7′ 0″	7 × 5/16″	41.0	5.38	8′ 0″ × 60′ 0″	4.39	1,374	.565	.930	115.0	Mean of 2 runs on mile	67.0	1.075	26.1 / 45.0	.424
21.3	147	156	4,800	30.8	140 / 160	1,811	11.61	.3773	.0861	2.650	2 D.E. 13′ 0″ × 16′ 0″	8 S.B. 3′ 10¾″	5′ 0″	768 × 3¼″ × 6′ 4″	8 × 5/16″	33.0	4.73	7′ 3″ × 68′ 6″	3.78	928	.512	.885	85.0	Mean between lights	52.0	1.135	27.4 / 45.0	.426
21.92	148	255	7.755	30.5	144 / 160	2,700	10.74	.35[illegible]3	.0931	2.830	2 D.E. 15′ 3″ × 17′ 0″	12 S.B. 3′ 6⅝″	6′ 0″	1,192 × 3¼″ × 6′ 9″	8 × 3/8″	51.0	5.00	9′ 0″ × 70′ 0″	4.01	1,730	.631	.800	125.0	Power not taken out of engines bet. lights	68.0	1.249	24.5 / 45.1	.441
23.86 / 22.45	150	212	7.661	36.1	150 / 160	3,245 / 3.053	15.29 / 14.40	.4230 / .3985	.0653 / .0694	2.361 / 2.509	2 D.E. 14′ 9″ × 18′ 6″	12 D.B. 3′ 3½″	5′ 5″	1,160 × 3¼″ × 6′ 6⅜″	7 × 7/16–3/8″	48.3	4.39	8′ 3″ × 80′ 0″	3.97	1,666	.513 / .546	.825	136.0	Mean on mile between lights	72.5	1.212	25.6 / 48.2	.513 / .484
22.85	151	140	4 516	32.2	156 / 163	1,828	13.06	.4048	.0765	2.470	2 D.E. 12′ 6″ × 16′ 0″	8 S.B. 3′ 4″	5′ 3″	712 × 3¼″ × 6′ 5″	8 × ¼″	30.5	4.59	7′ 0″ × 70′ 6″	3.64	1,000	.547	.869	80.0	Mean between lights	50.0	1.153	28.5 / 45.6	.466
20.74	152	90	2,747	30.5	155.5 / 160	1,120	12.4	.4077	.0804	2.453	2 S.E. 12′ 9″ × 9′ 10¼″	6 S.B. 3′ 0″	5′ 0″	368 × 3½″ × 6′ 6″	8 × ¼″	19.0	4.74	5′ 0″ × 38′ 0″	4.58	594	.530	.915	54.0	Mean of run on mile	29.0	1.093	26.0 / 48.4	.446
19.6	153	235	6,338	27.0	175 / 180	2 450	10.43	.3866	.0959	2.587	2 D.E. 14′ 0″ × 18′ 0″	12 S.B. 3′ 5″	5′ 9″	808 × 3½″ × 7′ 3″	7 × 7/16–3/8″	39.6	5.93	8′ 4″ × 71′ 6″	4.31	1,352	.551	.874	125.0	Mean of run on mile. Very bad coal	67.5	1.144	27.4 / 50.5	.442
2[illegible].63	H.F.D. C. of O.	154	6,438	41.8	160	3·200	20.78	.4570	.0481	2.012	2 S.E. 16′ 3¼″ × 12′ 0″	8 S.B. 3′ 6¾″	5′ 6″	1,028 × 2½″ × 8′ 0″	8 × ¼″	25.75	6.00	9′ 0″ × 65′ 0″	2.43	1,116	.349	.773	108.0	About one hour trial	62.5	1.295	27.6 / 48.6	.64
22.22	N. D. C. of O.	154	6.438	41.8	150	2 400	15.58	.3728	.0642	2.682	2 S.E. 16′ 3¼″ × 12′ 0″	8 S.B. 3′ 6¾″	5′ 6″	1,028 × 2½″ × 8′ 0″	8 × ¼″	25.75	6.00	9′ 0″ × 65′ 0″	2.43	1,116	.465	.773	108.0	About one hour trial	62.5	1.295	27.6 / 48.6	.48
24.0	154	235	6 338	27.	180	3 000	12.77	.4733	.0783	2.113	2 D.E. 14′ 0″ × 18′ 0″	12 S.B. 3′ 5″	5′ 9″	808 × 3½″ × 7′ 3″	7 × 7/16–3/8″	39.6	5.93	8′ 4″ × 71′ 6″	4.31	1,352	.450	.874	125.0	Mean between lights	67.0	1.144	27.2 / 50.4	.541
17.26	156	74.75	2,266	30.3	165	850	11.3	.3751	.0882	2.666	1 S.E. 15′ 5″ × 11′ 6″	4 3′ 3″	5′ 9″	244 × 3¾″ × 7′ 9″	7 × 3/8″	14.1	5.37	4′ 9″ × 43′ 0″	4.24	556	.654	.957	49.0	Mean 6 runs between lights	26.0	1.045	26.7 / 50.9	.391
28.0	156	74.75	2 266	30.3	150 / 160	984	13.2	.4342	.0761	2.303	1 S.E. 15′ 5″ × 11′ 6″	4 3′ 3′	5′ 9″	244 × 3¾″ × 7′ 9″	7 × 3/8″	14.1	5.37	4′ 9″ × 43′ 0″	4.24	556	.565	.957	49.0	Mean 2 runs on mile	26.0	1.045	26.7 / 50.9	.453
28.1	158	56	1 616	28.85	93.5 / 110	422	7.54	.261	.133	3.83	1 S.E. 13′ 0″ × 10′ 3″	3 S.B. 3′ 3″	5′ 9″	246 × 3″ × 6′ 10½″	7 × 3/8″	9.3	6.02	3′ 10″ × 33′ 6″	4.86	340	.806	.842	21.0	Between lights	15.8	1.19	26.0 / 34.58	.3103
27.24	159	56	1,616	28.85	97¾ / 110	572	10.21	.354	.0898	2.83	1 S.E. 13′ 0″ × 10′ 3″	3 S.B. 3′ 3″	5′ 9″	246 × 3″ × 6′ 10½″	10 × 3/8″	9.3	6.02	3′ 10″ × 33′ 6″	4.86	340	.594	.842	21.0	Mean on mile	15.8	1.19	26.0 / 34.58	.421
25.5	160	82.5	2 991	36.2	160	1.371	16.61	.458	.060	2.181	1 S.E. 17′ 3″ × 10′ 7″	4 A. 3′ 9″	5′ 6″	434 × 3¼″ × 6′ 9″	8 × 5/16–3/8″	19.08	4.32	5′ 6″ × 53′ 0″	3.97	486	.354	.827	53.3	Mean on mile	28.6	1.21	25.9 / 48.68	.554
21.4	160	82.5	2 991	36.2	160	1,150	13.93	.384	.072	2.6	1 S.E. 17′ 3″ × 10′ 7″	4 A. 3′ 9″	5′ 6″	434 × 3¼″ × 6′ 9″	8 × 5/16–3/8″	19.08	4.32	5′ 6″ × 53′ 0″	3.97	486	.422	.827	53.3	Between lights mean	28.6	1.21	25.5 / 48.68	.465



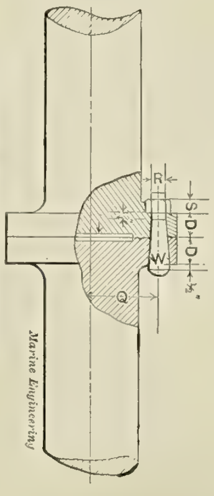
The approximate thickness by Whitworths Gage is shown by figures along side

Marine Engineering

DIAGRAM SHOWING SCOTCH PRACTICE IN DESIGNING PIPE LINES.



Bolts with 3/16 per foot Taper
Parallel Bolts shown as above Dia. =T



Bolts with 3/8″ per foot Taper

Marine Engineering

DETAILS OF CRANK SHAFTS AND COUPLINGS.

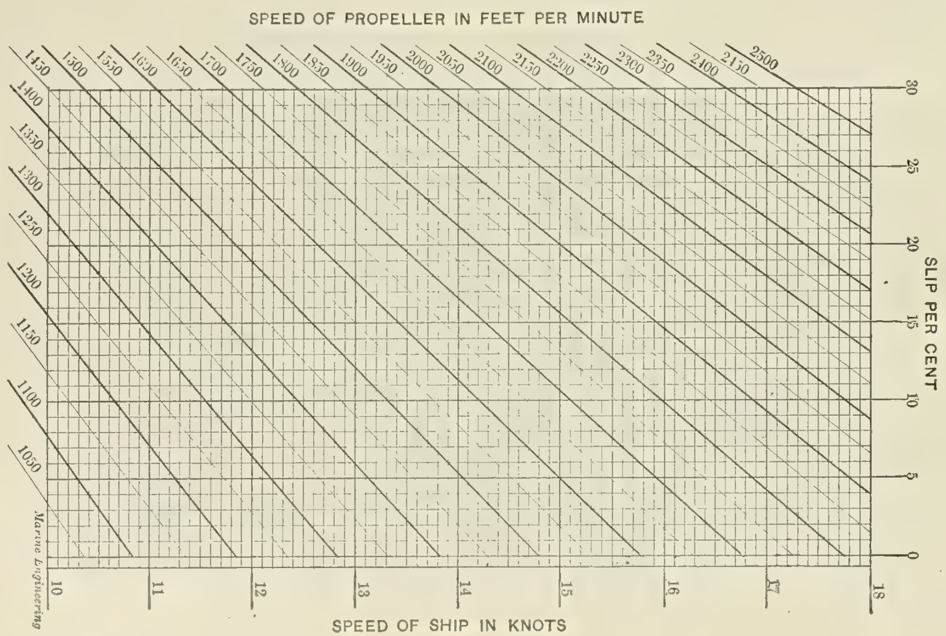
TABLE III.

Number of Engines.	Cylinders. Size.	Ratio. L. P. to H. P.	Ratio. M. P. to H. P.	Ratio. L. P. to M. P.	N. H. P.	I. H. P.	Boiler Pressure.	Trial. Steam.	Trial. Vac.	Revolutions per Minute.	Piston Speed.	M. E. P.	Calculated Mean Pressure.	Ratio M. E. P./C. M. P.	Number of Expansions.	Steam Cut Off in H. P	Steam Cut Off in M. P.	Steam Cut Off in L. P.	Mean Pressure in Cylinders. H. P	Mean Pressure in Cylinders. M. P.	Mean Pressure in Cylinders. L. P.	I. H. P. in Cylinders. H. P.	I. H. P. in Cylinders. M. P.	I. H. P. in Cylinders. L. P.	Receiver Pressure. M. P.	Receiver Pressure. L. P.	Weight of Engine, Net.	Total Weight in Boiler Room.	Total Weight in Engine Room.	Total Weight in Tunnel.	Total Weight of Spare Gear and Stores.	Total Weight of Donkey Boiler, Winches, Etc.	Total Weight of all Machinery.	I. H. P per Ton of Engine, Net.	I. H. P. per Ton of All in Engine Room.	I. H. P. per Ton of All in Boiler Room.	I. H. P. per Ton of All Machinery, Excluding Winches.
																"	"	"									Tons	Tons	Tons	Tons	Tons	Tons	Tons				
138	24"-40"-61"×3' 9"	6.46	2.78	2.32	246	1,583	160	160	26	69.4	520.5	34.34	55.26	.621	10 65	27.31	32.12	31.62	87.7	26 2	9.52	625.7	519.3	439	45.5	5	109	142	129	35.6	14.25	28	347	14.52	12.3	11.27	4 95
139	10¾"-16"-25"×1' 9"	6.783	2.22	3.06	39	268	150	144	26	159	556.5	25.86	46.5	.556	11.87	12	11.56	11.37	71.32	15.95	10 11	109	54	105	41.5	13	11.5	25.3	12	2.5	0.82	....	40.3	23.3	22.3	10 6	6.64
140	24"-35"-58"×3' 6"	5.84	2.508	2.33	210	1,328	140	135	27	82.65	578.5	28.67	.....	.....	.....	.....	.....	.....	51.99	23 26	9.79	412.1	462.4	453.5	46	7	93	134	107	26	1.15	9 5	276.7	14.28	12 4	10	4.97
141	25"-41"-68"×4' 0"	7.39	2.69	2 75	300	2,046	160	157.5	27¾	79	632	29.41	55 68	.528	10.32	Ab't 34⅝	Ab't 34⅛	Ab't 33⅝	74.9	27 18	9.42	704.2	687.2	655.2	55	8.25	107.3	189	128.5	16.5	6.2	38.5	378.7	19.07	16.9	10.8	6
142	28"-44"-74"×4' 3"	6.99	2.47	2.83	387	2,329	150	150	27½	74	629	28.41	55.89	.508	9.63	37	37.6	37.6	.....	.....	....	925	792	613	....	2.5	150 7	235	181 2	50	24.7	34 6	525 5	15.45	12.85	10	4.74
143	24"-38"-63"×3' 9"	6 89	2.506	2.748	241	1,460	160	158.5	26⅛	71.5	536.5	28.82	52.7	.547	11 27	27.5	32 2	32	75.37	25.77	9.57	554	475	431	41	6.5	108	170	125.5	42.3	12.3	28.6	378.7	13.52	11.63	8.6	4.17
144	28"-44"-74"×4' 3"	5 99	2.47	2.75	387	2,433	150	150	26½	68.5	582.25	32.06	55.89	.573	9.63	37	37.5	37.6	85 3	31.96	8.78	927	857	649	42.5	7	148 1	236 8	183 1	51.2	24.25	36 1	531.9	16 44	13 3	10.28	4.9
146	29"-58"×5' 0"	4	.....	.....	233	939	100	100	25	38.17	381.7	30.72	48.4	.536	7.00	34.5	.....	34.25	55.84	......	16.78	426	....	513	.....	13.75	53.5	84.2	57.9	Wheels 15.4	0.65	.....	158	17.56	16.23	11.15	5.94
147	24½"-38"-64"×4' 0"	6.82	2.4	2 836	275	1,811	160	137	25⅛	75⅞	607	30.6	53.3	.574	9.17	35.7	35.7	35 2	64.36	30.51	10.412	558	637	616	51.87	7.43	110	185.5	15	44	18	34.8	432 3	16.47	12.06	9.78	4 556
148	33"-49"-77"×4' 0"	5.79	2.344	2.46	415	2,740	160	144	26	59⅜	475	40.87	58.4	.7	8.60	32⅜	32.5	32.5	75	33.95	14 2	867	821	952	58	13⅜	153.5	250	196.5	60	31	46	583 5	17 85	13.94	10.56	5.09
149	29½"-48"-78"×4' 6"	6 99	2 647	2.647	463	2,913	160	149	27½	68.35	615 15	32.7	51.9	.63	10 63	35.5	35	35.5	71.69	30 64	10.9	913	1,033	967	43.35	4.62	161	265	247.5	64	15 5	43.5	635 5	18 09	11.75	11	4.92
150	29½"-48"-78"×4' 6"	6.99	2.547	2.647	463	3,202	160	157	27⅞	71.3	641.7	34.46	54 75	.63	10.54	35.8	35.75	35⅝	78.5	34.98	9.98	1,044	1,231	926	50.5	7	161	265	247.5	64	15.5	43.5	635 5	20	12.93	12.08	5.41
151	24"-39"-64"×3' 6"	7.11	2.54	2.69	241	1,828	163	156.5	27	82.94	580.6	32.3	54.17	.596	10.66	28	29	28	69 8	30 15	11.59	550	627	650	61.35	9 57	88	182.8	119 9	39.2	12.2	30	384	20 77	15.25	10	5.16
152	15"-24"-39"×2' 6"	6.76	2.56	2 644	155	1,123	160	150	25½	128.5	599.6	25 86	50 54	.511	11 13	17	17.4	17⅞	49.22	25 26	8.99	158	208	195	59	7.25	47 5	104	58	15	0.5	.....	177.5	23.64	19.36	10.8	6.32
153	25½"-42"-71"×4' 3"	7.75	2.712	2.85	352	2,438	180	174.5	25⅝	66	561	36.22	69 53	.608	10.74	36.8	35.6	32.2	104 6	29 4	12.4	908	692	838	57.75	11	144 5	250	188.5	55	14.65	38 6	546.8	16 87	13	9.75	4.8
154	25½"-42"-71"×4' 3"	7.75	2.712	2.85	352	3,002	180	177.5	24½	73.5	624.75	40.05	61.85	.647	10.4	Ab't 38	Ab't 36	Ab t 32.5	95	40 76	13.36	918	1,070	1,014	65	14.5	144 5	250	188.5	55	14.65	38.6	546.8	20.8	15.92	12	5.91
						850		147.5	26.6	105.56	680.6	30.37		.572											39.6	6.67								19.43	14.6	8.83	5.07
156	17"-28"-45"×2' 9"	7.006	2,712	2.85	104	984	165	150	26½	109.62	602 9	33 88	53.07	.638	10.16	22.75	23.5	21.5	78.9	29.1	11.37	327.1	327	330	49	10	43.8	95.3	58.2	12.5	0.53	.....	167.5	22.5	17	10.2	5.87
City of Oxford	31"-50"-83"×5' 0"	7.168	2 601	2.75	616	3,018	150	150	25	62.75	627.5	29.33	51 8	.566	10 75	Ab't 40	Ab't 40.5	Ab t 36	69.7	27.28	9.71	1,001	1,018	999	55	9.5	.....	....	.....	....	.....	.....	.....	.....	.....	.....	.....
158	22"-42"×3' 6"	3.644	.....	.....	87	422	110	93.5	....	45.44	318	31.65	....	.....	.....	.....	.....	.....	59.64	.....	15.19	218.6	.....	205.8	.....	6⅝	.....	47 4	.....	Wheels 0.9	0.3	.....	95.1	.....	.....	8 91	4.44
159	18"-36"×2' 3"	4	.....	.....	54	572	110	100 5	24¾	122.5	551	33.64	45.26	.743	7.78	18.5	....	18.5	48.41	.....	21.32	206.5	.....	366 3	.....	23.5	.....	46.5	22 6	5.2	1 15	.....	75 4	.....	25.36	12.31	7.59
160	20"-33"-54"×3' 6	7.29	2.722	2.677	171	1,149	160	151.6	27.7	74.94	524	31.57	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	78 4	113.8	110.4	26.8	2.35	43.4	296.1	14.65	10.4	10.1	4.53

TABLE VI.- CRANK SHAFTS.

A.	B	C.	D.	E.	F.	G.	H.	K.	L.	M.	N.	O.	P.	Q.	R.	S.	T.	U.	V.	W.	No. of Bolts.	A.
10	11	19½	2⅞	1½	10	18	19¼	6⅞	13¾	1¾	5¼	1¼	4	7⅝	2	1⅝	2[illegible]	1¼	3[illegible]	2½	6	10
10¼	11¼	20½	3	1½	10¼	18½	19¾	7	14¼	1¾	5¼	1¼	4	8	2⅛	1¾	2½	1¼	3¾	2⅝	6	10¼
10½	11½	20½	3	1½	10½	18⅞	20½	7¼	14½	2	5½	1½	4¼	8	2⅛	1¾	2½	1¼	3¾	2¾	6	10½
10¾	11¾	21½	3⅛	1½	10¾	19⅜	20½	7⅝	14¾	2	5½	1½	4¼	8⅛	2¼	1¾	2⅝	1⅜	3 15/16	2¾	6	10¾
11	12	21½	3⅛	1¾	11	19⅞	21	[illegible]	15⅛	2	5¾	1½	4½	8⅜	2¼	1¾	2[illegible]	1[illegible]	3 15/16	2¾	6	11
11¼	12¼	22½	3¼	1¾	11¼	20¼	21½	7¾	15½	2	5¾	1½	4½	8⅝	2⅜	1[illegible]	2[illegible]	1[illegible]	4⅛	3	6	11¼
11½	12½	22½	3¼	1¾	11½	20¾	21⅞	7⅞	15⅞	2¼	6	1½	4½	8⅞	2⅜	1[illegible]	2[illegible]	1[illegible]	4⅛	3	6	11½
11¾	12¾	23½	3⅜	1¾	11¾	21⅛	22⅜	8	16¼	2¼	6	1½	4¾	9⅛	2⅜	1[illegible]	2[illegible]	1½	4 5/16	3⅛	6	11¾
12	13	23½	3⅜	1¾	12	21⅝	22¾	8¼	16½	2¼	6¼	1½	4¾	9⅛	2⅜	1[illegible]	2[illegible]	1½	4 5/16	3¼	6	12
12¼	13½	24½	3½	2	12¼	22	23⅝	8⅜	16⅞	2¼	6½	1½	5	9½	2½	1[illegible]	3	1½	4½	3¼	6	12¼
12½	13¾	24½	3½	2	12½	22½	24	8⅝	17¼	2¼	6½	1½	5	9½	2½	1[illegible]	3	1½	4½	3¼	6	12½
12¾	14	25	3⅝	2	12¾	23	24½	8¾	17½	2¼	6½	1½	5¼	9 13/16	2½	1[illegible]	3[illegible]	1[illegible]	4[illegible]	3⅜	6	12¾
13	14¼	25	3⅝	2	13	23⅜	25	8⅞	17⅞	2½	6¾	1¾	5¼	9 13/16	2½	1[illegible]	3[illegible]	1[illegible]	4[illegible]	3⅜	6	13
13¼	14½	26	3¾	2	13¼	23⅞	25⅜	9⅛	18¼	2½	7	1¾	5¼	10	2⅝	2	3¼	1[illegible]	4 15/16	3½	6	13¼
13½	14¾	26	3¾	2	13½	24⅜	25⅞	9¼	18⅝	2½	7	1¾	5½	10	2⅝	2	3¼	1[illegible]	4 15/16	3½	6	13½
13¾	15	27	4	2	13¾	24¾	26¼	9⅜	18⅞	2½	7	1¾	5½	10⅛	2⅝	2	3⅜	1¼	5⅛	3⅜	6	13¾
14	15¼	27	4	2¼	14	25¼	26¾	9⅝	19¼	2½	7¼	1¾	5¾	10⅜	2⅝	2	3⅜	1¾	5⅛	3⅝	6	14
14¼	15½	28	4⅛	2¼	14¼	25⅝	27½	9¾	19[illegible]	2½	7⅜	1¾	5¾	10¾	2¾	2	3½	1[illegible]	5 5/16	3¾	6	14¼
14½	15¾	28	4⅛	2¼	14½	26	27½	10	20	2½	7⅝	1¾	6	10¾	2¾	2	3½	1¾	5 5/16	3¾	6	14½
14¾	16	29	4¼	2¼	14¾	26½	28	10⅛	20¼	2½	7¾	1¾	6	11⅛	3	2¼	3[illegible]	1[illegible]	5 9/16	3[illegible]	6	14¾
15	16¼	29	4¼	2¼	15	27	28½	10¼	20⅝	2¾	7¾	1¾	6	11⅛	3	2¼	3[illegible]	1[illegible]	5 9/16	3[illegible]	6	15
15¼	16½	27½	4⅛	2¼	15¼	27½	28[illegible]	10½	21	2¾	8	1¾	6¼	10[illegible]	2½	1[illegible]	3[illegible]	1[illegible]	4¾	3[illegible]	9	15¼
15½	16¾	27½	4⅛	2¼	15½	27⅞	[illegible]	10⅝	21⅜	2¾	8	1¾	6¼	10[illegible]	2½	1⅞	3	1[illegible]	4¾	3⅜	9	15½
15¾	17	28½	4¼	2¼	15¾	28⅜	29¾	10¾	21⅝	2¾	8¼	1¾	6¼	11¼	2⅝	2	3¼	1[illegible]	4 15/16	3½	9	15¾
16	17¼	28½	4¼	2½	16	28⅞	30¼	11	22	2¾	8¼	1¾	6½	11¼	2⅝	2	3¼	1[illegible]	4 15/16	3½	9	16
16¼	17¾	29¼	4⅜	2½	16¼	29¼	31⅛	11[illegible]	22⅜	2¾	8½	1¾	6½	11½	2⅝	2	3[illegible]	1¾	5[illegible]	3⅝	9	16¼
16½	18	29¼	4⅜	2½	16½	29¾	31½	11[illegible]	22¾	2¾	8½	1¾	6¾	11½	2⅝	2	3[illegible]	1¾	5[illegible]	3⅝	9	16½
16¾	18¼	30¼	4½	2½	16¾	30⅛	32	11[illegible]	23	2¾	8¾	1¾	6¾	11[illegible]	2¾	2	3½	1¾	5 5/16	3¾	9	16¾
17	18½	30¼	4½	2½	17	30⅝	32⅜	11[illegible]	23[illegible]	2¾	8¾	1¾	6¾	11[illegible]	2¾	2	3½	1[illegible]	5 5/16	3¾	9	17
17¼	18¾	31½	4⅝	2½	17¼	31	32⅞	11[illegible]	23¾	2¾	9	1¾	7	12[illegible]	3	2¼	3[illegible]	1[illegible]	5 5/16	3[illegible]	9	17¼
17½	19	31½	4⅝	2½	17½	31½	33¼	12	24⅛	2¾	9	1¾	7	12⅜	3	2¼	3⅝	1⅞	5 5/16	3⅞	9	17½
17¾	19¼	32	4¾	2½	17¾	32	33¾	12⅛	24⅜	2¾	9¼	1¾	7¼	12⅝	3	2¼	3⅝	..	...	3⅞	9	17¾
18	19½	32	4¾	2½	18	32⅜	34⅛	12⅜	24¾	2¾	9½	1¾	7¼	12⅝	3	2¼	3⅝	1⅞	5 5/16	3⅞	9	18

with capacities of Scotch marine boilers; these engines and boilers having been built by one of the oldest shipbuilding firms on the Clyde. These sizes were calculated after years of experience from actual data taken from Tables III and IV, which give ratios of engines, cylinders, steam pressure, vacuum, cut-off, weights of



SPEED OF SHIP AS AFFECTED BY SLIP OF PROPELLER.

TABLE V.

Number of Engine.	Cylinders.	Boiler Pressure.	Mean Pressure and Maximum Initial Pressure from Cards. High.	Mean.	Low.	Initial Pressure × Cylinder Area. High.	Mean.	Low.	Boiler Pressure × H. P. Cylinder Area.	Main Bearings Diameter × L.	Crank Pin Diameter × L.	Cross Head Diameter × L.
138	24'' 40'' 61'' 3' 9''	160	91.3 131	28.1 39	9.65 11	59,251	49,015	32,147	72,368	13½''×17''	13¾''×12⅛''	7'' ×6''
139	10¾'' 16'' 28'' 1' 9''	150	72 103	15.16 30	10.575 15	9,348	6,030	9,235	13 614	5½''× 7½''	5½''× 5⅝''	3'' ×5''
140	24'' 38'' 58'' 3' 4''	140	52.9 90	23.24 46	9.71 15	40,707	52,168	39,630	63,330	12¼''×17¾''	12¼''×11¾''	6¼''×5¾''
141	25'' 41'' 68'' 4' 0''	160	78.1 114	27.74 47	9.6 16	55,951	62,054	58,107	78,528	13½''×24''	13¾''×14''	7½''×6½''
142 144	28'' 44'' 74'' 4' 3''	150	83 110	31.5 40	10.1 15	67,727	60,820	54,515	92,355	15'' ×17''	15'' ×17''	8½''×7½''
146	29'' 58'' 5' 0''	100	60.24 81	......	17.58 28	53,500	......	73,978	66,050	11'' × 5''	7'' ×10''	5'' ×5½''
147	24½'' 38'' 64'' 4' 0''	150	68.6 97	33 45	11.1 17	45,726	51,030	54,689	75,424	13'' ×15''	13¼''×12¼''	7'' ×6''
148	32'' 49'' 77'' 4' 0''	160	77.04 105	35.825 50	14.175 22	84,441	94,285	102,445	128,672	14½''×18''	14½''×16''	8½''×7½''
150	29½'' 48'' 78'' 4' 6''	160	80 102	35.7 50	10.065 14.5	69,706	90,480	59,286	108,344	15⅛''×14¼''	15⅛''×14¾''	8½''×7½''
151	24'' 39'' 64'' 3' 6''	163	68.4 96	32.08 50	12.76 18.5	43,420	59,730	59,514	73,741	12¼''×13''	12½''×10½''	6¼''×5¾''
152	15'' 24'' 39'' 2' 4''	160	56.74 90	28.24 50	9.58 16	15,903	22,620	19,113	28.272	7¾''× 8½''	7¾''× 7⅝''	3¾''×7''

Number of Engine.	Bearing Pressure Induced by Maximum Initial Pressure × Piston Area. Boiler Pressure × Piston Area. M. Bear.	C. Pin.	× Head.	Bolts. M. B.	C. P.	× Head.	Stress on Bolts. Maximum Initial Pressure × Piston Area. M. B.	C. P.	× Head.	Piston Rod Diameter.	Revolutions.	Piston Rod. Load per Sq. Inch.	Guide Shoes.	Guides. Load per Square Inch.
138	129 157.5	344.8 421	705.4 861.5	4 at 3''	2 at 4''	4 at 3''	2,727 3,331	2,962.5 3,618.4	2 727 3,331	5¼ 6¼	69.2	4.070 2,359	7' 6'' 21'' ×17''	52.5
139	113 165	302 440	523 907.6	4 at 1½''	2 at 1⅝''	2 at 1⅝''	1,800 2 618	3 000 4,363	3,000 4,363	2 2¾	160	5,893 2,307	3' 6'' 14'' × 8½''	43.6 29.5
140	120 145.6	362 440	726 882	4 at 3''	2 at 3¾''	4 at 2¾''	2,404 2,916	2,944 3.573	2.810 3,412	4¾ 5¾	82.68	4,363 2 440	6' 8'' 21'' ×15''	51.8
141	Double. 96 121	322 407	626 805.5	4 at 3¾''	2 at 4¼''	4 at 3¼''	1.751 2,210	2,707 3,404	2,386 3 020	5⅝ 7	79	3,644 2,040	9' 0'' 24'' ×15''	87.5 49.6
142 144	133 181	266 363	531 724	4 at 3¾''	2 at 4¾''	4 at 3¼''	1,911 2 323	2,328 3,176	2,600.8 3,546	6¾ 8¼	68.85	3.826 1.727	9' 6'' 24'' ×18½''	47.8
146	221 200.1	1,056 943	1 345 1,201	4 at 2½''	2 at 3''	Cutters.	3,774 3,369	5 233 4,673	Cutters.	5 5½	38	3.364 2,781	10' 0'' 2 at 7''×16''	76
147	140 193.3	337 464.7	651 898	4 at 3''	2 at 4''	4 at 3''	2.518 3 472	2 739 3,771	2,578 3 472	5⅛ 6¼	78	4,570 2,460	8' 0'' 21'' ×17''	54.5
148	196 246	441 554	802 1,009	4 at 3¾''	2 at 4¾''	4 at 3½''	2,890 3,630	3 532 4 436	3.374 4 238	6¾ 8½	60	4 210 2.268	9' 0'' 24'' ×18½''	62.4
150	208 253	406 507	709 857.5	4 at 4''	2 at 4¼''	4 at 3½''	2,262 2,733.6	3,944 4,770	2,980 3,601	6¼ 7½	72.58	4.238 2,475	9' 0'' 27½''×18''	57
151	187 232	455 562	832 1,027	4 at 3''	2 at 3¾''	4 at 2¾''	2,750 3,395	3,370 4,161	3.218 3.973	5 6½	84	4,877 2 222	7' 0'' 21'' ×12''	75.6
152	172 214.5	383 479	861 1 077	4 at 2''	2 at 2¼''	2 at 2¼''	2,450 3,060	3.770 4,712	3,770 4.712	3 3¾	130	5 206 2,560	5' 0'' 14½''× 7½''	52.5

different parts on shipboard; and figures on indicated horsepower, grate surface, heating surface, ratio of grate surface to heating surface, steam pressure on trial trips, and total weight of boiler with or without water for corresponding boilers for the engines of Table III.

In Table V are tabulated the cylinder dimensions, boiler pressure, M.E.P., cylinder area, speed, etc., of eleven different marine engines, together with sizes of bolts and guide shoes used on same.

Table VI gives sizes of parts for crank shafts. This will be found very useful for reference in designing the details of cranks, pins, etc., for these parts have stood the test of actual mercantile marine and British Government service, being of ample proportions to carry their respective stresses, and presenting adequate bearing surface.

The chart deals with speed of ship in knots per hour. To follow this table you get slip percent; follow the line down until it cuts speed of propeller in feet per minute; then carry the line to the right; this gives the knots per hour; this table is useful on trial trips.

MOTOR BOATS, V.

BY DR. WILLIAM F. DURAND.

THE MOTOR-BOAT ENGINE.—(*Continued.*)

Carbureter.—The carbureter occupies toward the gasoline engine a relation entirely different from anything found in the steam engine or its operation. The fuel comes to the engine in the form of a liquid. Before it can be burned it must be brought to the condition of vapor mixed with a certain amount of air. It is the function of the carbureter, or vapor generator, as it is sometimes termed, to thus prepare the liquid fuel for combustion as a vapor in the engine. The importance of the carbureter and of its operation cannot be overestimated, and it is not too much to say that of the various troubles with the gasoline engine, by far the largest part are caused directly or indirectly by imperfect carburetion. The fundamental requirements for a carbureter are as follows:

(1) To produce a mixture of vapor and air within narrowly varying proportions of each.

(2) To produce such mixture independent of the speed of the engine or the temperature of the atmosphere.

(3) To use up completely the gasoline fuel, and not merely the more volatile portions, as in certain early forms.

The fundamental principle on which all carbureters operate involves the intimate mingling of gasoline and air under conditions suitable for vaporization. Vaporization is always a surface phenomenon; that is, a liquid can evaporate only at a surface which is in contact with air. The real problem consists, therefore, in bringing large surfaces of gasoline and air into contact, and under a temperature suitable for the evaporation of the former. This has been brought about in various ways. Early forms have consisted essentially of means for spreading out the gasoline in a thin layer or film and passing the air over it on its way to the engine cylinder. A further extension of this idea includes a series of wicks or layers of fibrous material in which the gasoline rises by capillary attraction and thus becomes exposed in large surfaces to the entering current of air. A variety of arrangements in detail are met with but in all cases the same underlying principle is found—the spreading out of the gasoline into a thin film exposed to the stream of inflowing air.

In a different and later type of carbureter air is allowed to bubble through the gasoline, absorbing vapor on its way and thus accomplishing the same general purpose. This constitutes in effect a fine subdivision of the air with correspondingly large surface in contact with the body of gasoline through which it is passing on its way to the engine. Many forms in detail have embodied this principle, later developments including a float arrangement for insuring a constant level and a uniform depth of gasoline through which the air passes.

The fundamental objection to carbureters of these two forms lies in the fact that the vaporization is selective. It is readily seen that under the conditions described the more volatile portions of the gasoline will be first vaporized, leaving the heavier portions behind and causing a continuously increasing density in the residual liquid. This will tend to clog the wicks in forms using such appliances, and in all cases will gradually interfere with the operation of the apparatus as intended.

In order to obviate this fundamental objection, later forms of carbureter operate by means of a jet of the liquid fuel spurted into the stream of inflowing air. This operation gives first a mechanical spray directed into the stream of air, and this flashes quickly into vapor, thus achieving the purpose in view. By this method the fuel is vaporized completely and not selectively, and thus the body of gasoline remains of constant quality. The jet of liquid is produced by the suction of the piston on the indrawing stroke. This forms a partial vacuum in the cylinder and connecting passages, and in answer to this difference of pressure air rushes in through the air inlet, and a jet of liquid fuel likewise enters through the gasoline nozzle. Such carbureters fall into

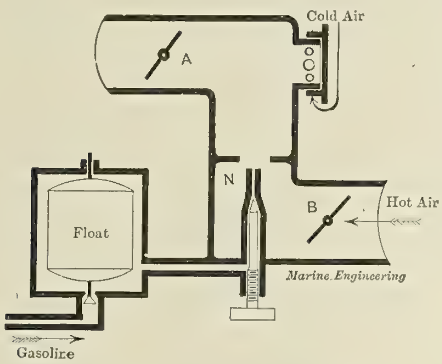


FIG. 31.—FLOAT-FEED CARBURETER.

two classes, according to whether or not a constant level of gasoline is maintained at the nozzle. These general principles are illustrated in Figures 31 and 32. In Fig. 31 is shown in schematic form a typical arrangement of float-feed carbureter. The weight of the float is so adjusted to the density of the gasoline that with the liquid in the float chamber at the level of the jet nozzle *N*, the valve at the bottom of the float will be just closed. If the level of the liquid drops, the float will drop likewise, the valve is more widely opened, and the gasoline enters at an increased rate. If, on the other hand, the level should tend to rise above the level of the nozzle, thus producing a waste at the nozzle, the float rises and closes the bottom valve tightly, thus shutting off the supply. In this manner the liquid is maintained always just at the mouth of the nozzle *N*, and ready to enter as a jet the instant the pressure is reduced by the instroke of the piston. The throttle *B* is provided to control the inflow of the air relative to the gasoline, and thus the richness of the mixture. The throttle *A* is provided to control the inflow of the mixture as a whole, and thus the power developed per stroke.

In Fig. 32 is shown a simplified form in which no attempt is made to maintain a constant level of gasoline. The arrangement consists essentially of an angle-check valve. The opening *A* connects with the cylinder and the valve is kept seated by a light spring as shown. On the instroke the valve rises under the influence of the pressure resulting from the partial vacuum on the upper side, and air enters from *B*. The gasoline enters through an opening controlled by a needle valve, and fills a channel *C*, extending around the valve casing. From this passage several small openings connect with the seat of the valve, so that the opening of the valve results as well in the uncovering of these apertures, from which the gasoline enters and is caught by the stream of inflowing air as in other forms.

In certain other patterns of carbureter a constant level is maintained by pumping an excess of gasoline into a chamber, out of which it flows through the open mouth of an overflow pipe. This maintains a constant level even with the mouth of the overflow, and then combined with this may be fitted various arrangements of air inflow and gasoline-jet passage.

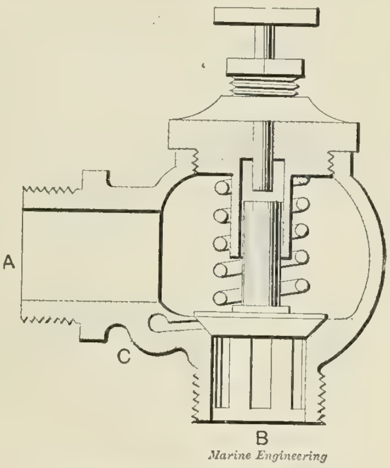


FIG 32.—ANOTHER FORM OF CARBURETER.

On the operation of the modern typical form of carbureter increase in revolutions per minute is accompanied by a decrease in the amount of air entering per stroke, with an increase in the suction head on the gasoline, combined with a decreased time during which such head can act. Without other adjustment, however, the proportion of air will become too small with extreme speeds of rotation, and the mixture will thus become too rich for the best results. To guard against this condition an auxiliary air inlet is often provided, which is opened automatically at high speeds. This is intended to maintain the proper proportion between air and gasoline nearly constant at all speeds of rotation.

(To be continued.)

Dock Trials of the United States Battleship Connecticut.

The main engines of the United States battleship *Connecticut*, which is building at the navy yard, New York, were recently given a dock trial. The engines were run separately on alternate days, three days being devoted to the trial of each engine. The actual running time for each engine was about twenty hours. During the first day's trial of each engine the revolutions averaged from 35 to 40, only two boilers being used. On the second day's trial the revolutions were increased to an average of about 60, four boilers being used. On the third and last day's run eight boilers were used, the revolutions averaging between 75 and 80, the maximum being, when the engines did not race, 86 for the port engine and 84 for the starboard one.

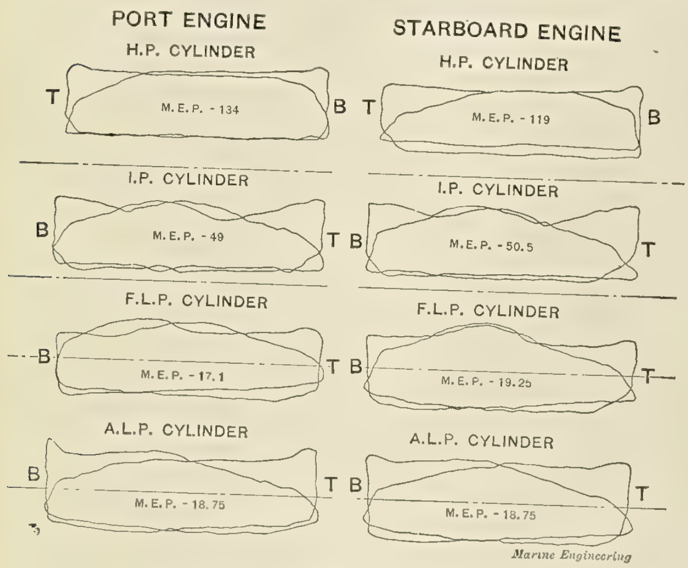
Indicator cards were taken at various speeds from each engine, the results plotted on cross-section paper, and the revolution-power curve constructed as shown. It will be noticed that the starboard engine required more horsepower for the same number of revolutions than the port one. This was due to the starboard side of the ship being next to the dock. The port engine showed a tendency to race, and at one time the revolutions reached 104 per minute without any increase in the steam pressure. It will be interesting to compare this curve with a similar one in free route, which will be drawn when the screws are standardized for the preliminary contract trial. With the same mean pressure upon the pistons as the cards show for the higher revolutions at the dock, the revolutions should be, in free route, a little over 120 per minute.

Although this was the first time the engines had ever been turned under steam they ran easily and smoothly, apparently being in perfect adjustment. No water was used on any of the bearings, nor allowed to circulate through any of the hollow brasses or guides, with the exception of the thrust bearings, when; owing to the increased thrust due to the ship being fast to the dock, water was allowed to circulate through the cooling coil and to a limited extent through the hollow horseshoes. The results of this trial show the excellent character of the work done by the employees at the New York navy yard.

The principal dimensions of the *Connecticut* are as follows:

Length	450 ft. 0 ins.
Beam	76 ft. 10 ins.
Draft, normal	24 ft. 6 ins.
Draft, full load	26 ft. 9¼ ins.
Displacement, normal	16,000 tons
Displacement, full load	17,666 tons
Speed at normal displacement	18 knots

The engines are designed for a total of 16,500 horsepower at 120 revolutions, with 265 pounds steam pressure at the boilers. They are of the usual vertical, four-cylinder, triple-expansion type, the high- and intermediate-pressure cylinders being in the center, and one low-pressure cylinder at each end. The cranks for the forward pair of cylinders and also for the after pair are opposite to each other, while the two pairs are set at right angles. The framing is all of forged steel, consisting of vertical columns well trussed by suitable stays. Piston valves are used on all the



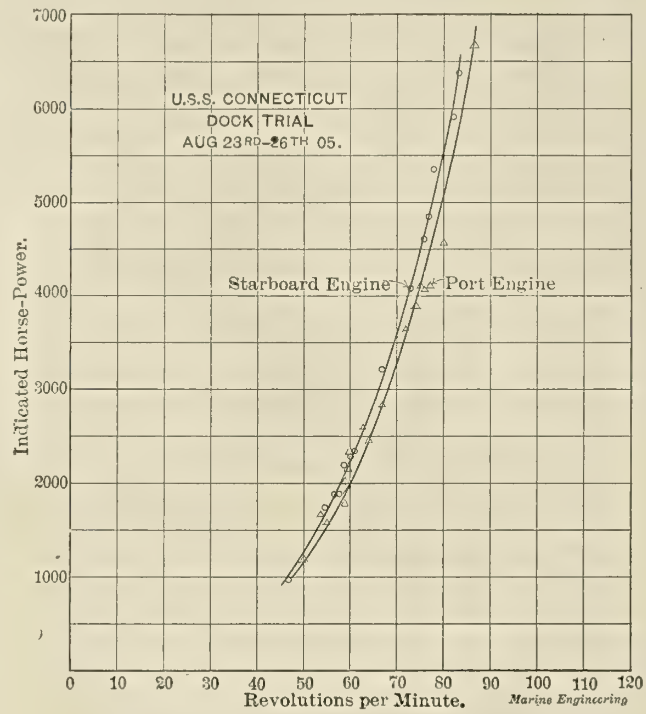
SAMPLE INDICATOR CARDS FROM THE CONNECTICUT.

cylinders and are worked by the usual double-bar Stephenson link motion. The crank shafts are hollow, forged in two sections, each section having two cranks opposite to each other. This is done to keep the cylinders as close to each other as possible, and thus reduce the vibration.

The principal dimensions of the engines are as follows:

Diameters of the cylinders	32½, 53, and two of 61 ins.
Stroke	48 ins.
Diameter of piston rods	7¼ ins.
Length of connecting rods between centers	96 ins.
Diameter at neck	6⅞ ins.
Diameter at crank end	8 ins.
Diameter of crank pins	17½ ins.
Length of crank pins	19 ins.
Diameter of crank-shaft bearings	16½ ins.
Length of crank-shaft bearings	19½ ins.
Cooling surface of each condenser	10,375 sq. ft.

The boilers are of the Babcock and Wilcox type, having 52,752 square feet of heating surface and 1,097 square feet of grate surface, a ratio of 48.1 to 1.



POWER-REVOLUTION CURVES FROM DOCK TRIAL.

A sample set of cards from each engine is shown.

RESULTS OF TRIAL.

	PORT ENGINE.	STARBOARD ENGINE.
Revolutions per minute	86.	83.
I. H. P., high-pressure cylinder	2,260.78	1,942.35
I. H. P., intermediate cylinder	2,232.11	2,221.42
I. H. P., forward low-pressure	1,035.01	1,124.09
I. H. P., after low-pressure	1,134.49	1,094.89
I. H. P., collective	6,662.39	6,382.75
Steam pressure, per gauge	265.	255.
First receiver pressure, absolute	98.	98.
Second receiver pressure, absolute	35.	32.
Vacuum, in inches	25.5	25.5
Total indicated horsepower	13,045.14	

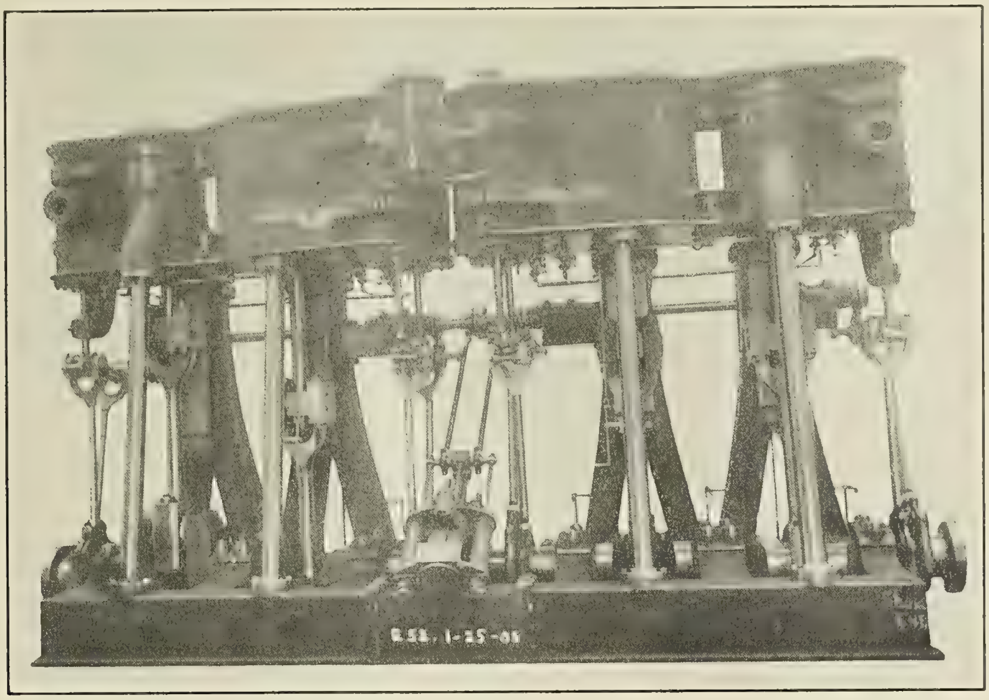
H. P. Norton.

Trial Trip of Ferryboat Manhattan.

On June 22 the Maryland Steel Company sent down the Patapsco River and Chesapeake Bay for an official trial trip the new ferryboat *Manhattan*, which they have built for the city of New York service between the Battery and Staten Island, and which has been described at considerable length in our columns in three or four numbers during the past year or more.

These boats have a length over all of 250 feet; length between perpendiculars, 246 feet; a molded beam of 46 feet; an extreme beam over the guards of 66 feet, and a depth of 19 feet 6 inches. At the time of the trial trip the draft at what has been called the "shore" end was 11 feet 10 inches, while that at the "water" end was 11 feet 8 inches, giving a mean draft of 11 feet 9 inches. This corresponds with a displacement of 1,376 tons, and a wetted surface of 9,480 square feet. The water tanks were full, and the coal bunkers contained 60 tons.

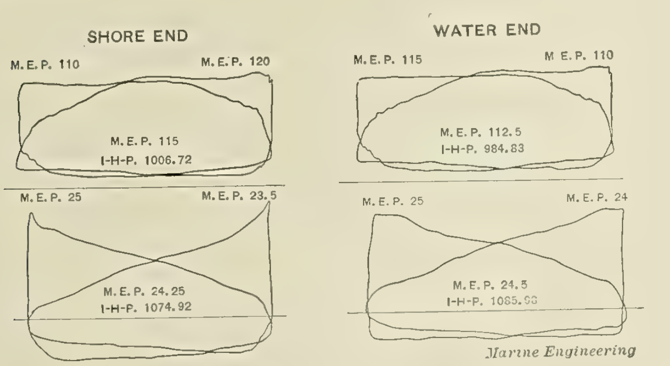
The table giving the log of the trial trip shows a mean speed on the down trip of 15.34 knots, or 17.67 miles per hour. The same figures for the up trip were 15.16 and 17.47. This makes the average speed for the trial 15.25 knots, or 17.57 miles per hour.



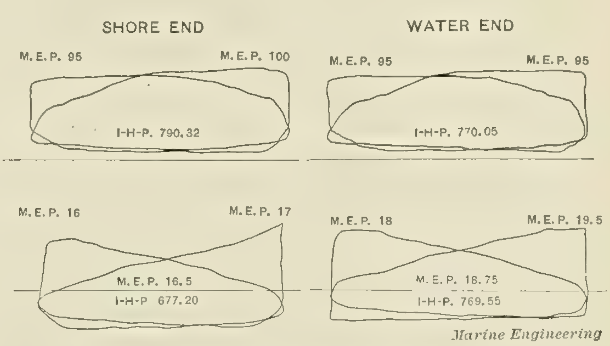
DOUBLE COMPOUND ENGINES OF FERRYBOAT MANHATTAN.

The boat is propelled by a double compound engine coupled together, with a continuous shaft carrying a propeller at each end of the boat. The cylinders measure 22½ and 50 inches in diameter, with a stroke of 30 inches. We present a photograph of this engine.

The boilers, which are of the Babcock and Wilcox marine type, are four in number, and work under a pressure of 225 pounds per square inch. The total grate surface is 340 square feet and the heating surface is 12,500 square feet, this giving a ratio between the two of 36.8 to 1. The propellers have a diameter of 11 feet, and with a pitch ratio of 1.3 the pitch works out at 14 feet 4 inches.



CARDS TAKEN AT FULL POWER.



CARDS TAKEN AT THREE-FOURTHS POWER.

Run.	Time. h. m. s.	Distance Between Points.		Speed.		Mean R. P. M.	Mean Steam Pressure.	Mean I. H. P.	Slip. %
		Statute Miles.	Nautical Miles.	Statute Miles.	Knots.				
A *	0 30 3	8.5	7.4	16.98	14.76	147.3	150	3,865	28.4
B *	1 1 22	17.5	15.2	16.78	14.58	147	147	3,832	30.6
C *	0 56 25	17.5	15.2	18.37	15.90	145.6	145	3,670	25
Total * ...	2 27 50	43.5	37.8	17.67	15.34	146.5	146.8	3 773	27.9
C †	0 59 43	17.5	15.2	17 34	15.06	141	143	.....	24.4
B †	1 2 19	17 5	15.2	16.58	14.40	141.6	145	.....	27.9
A †	0 27 33	8.5	7.4	18.54	16.10	152.8	155	.....	25.5
Total †	2 29 35	43.5	37.8	17.47	15.16	143.6	146.2	.....	26

* Down, against wind, against tide.
† Up, against tide, with wind.
A, between Sandy Point and Thomas Point. B, Between Thomas Point and Sharp's Point. C, Between Sharp's Point and Cove Point.

The following table is of unusual interest, showing as it does how the displacement of the ancient and modern ship will add up:

Weight as a Percentage of the Total Displacement.	74-gun Ship, 1805.	Battleship, 1905.
General equipment	20 (Ex-masts.)	4
Armament	10	19
Propelling arrangements	8.5 (Masts, sails, and rig.)	10.5
Coal	0	5.5
Ballast	6.5	0
Armor	0	26
Hull	55	35
	100	100

GOVERNMENT DREDGE FOR DELAWARE RIVER.

This dredge, the sixth of similar type built by the Maryland Steel Company for the Engineers' Department of the United States Army, is the largest and finest of the lot. Designs of hull, machinery, pumping engines, and pumps were furnished by Capt. E. O. Patterson of the Engineers' Department, who is superintending the construction, under orders of Major J. C. Sanford.

The operation of the dredge is similar to that described in our issue of July, 1904, for the New York harbor dredges.

HULL.

General dimensions are as follows:

Length, between perpendiculars	300 ft. 0 ins.
Length, over all	315 ft. 0 ins.
Beam, molded	52 ft. 0 ins.
Depth, molded	22 ft. 6 ins.

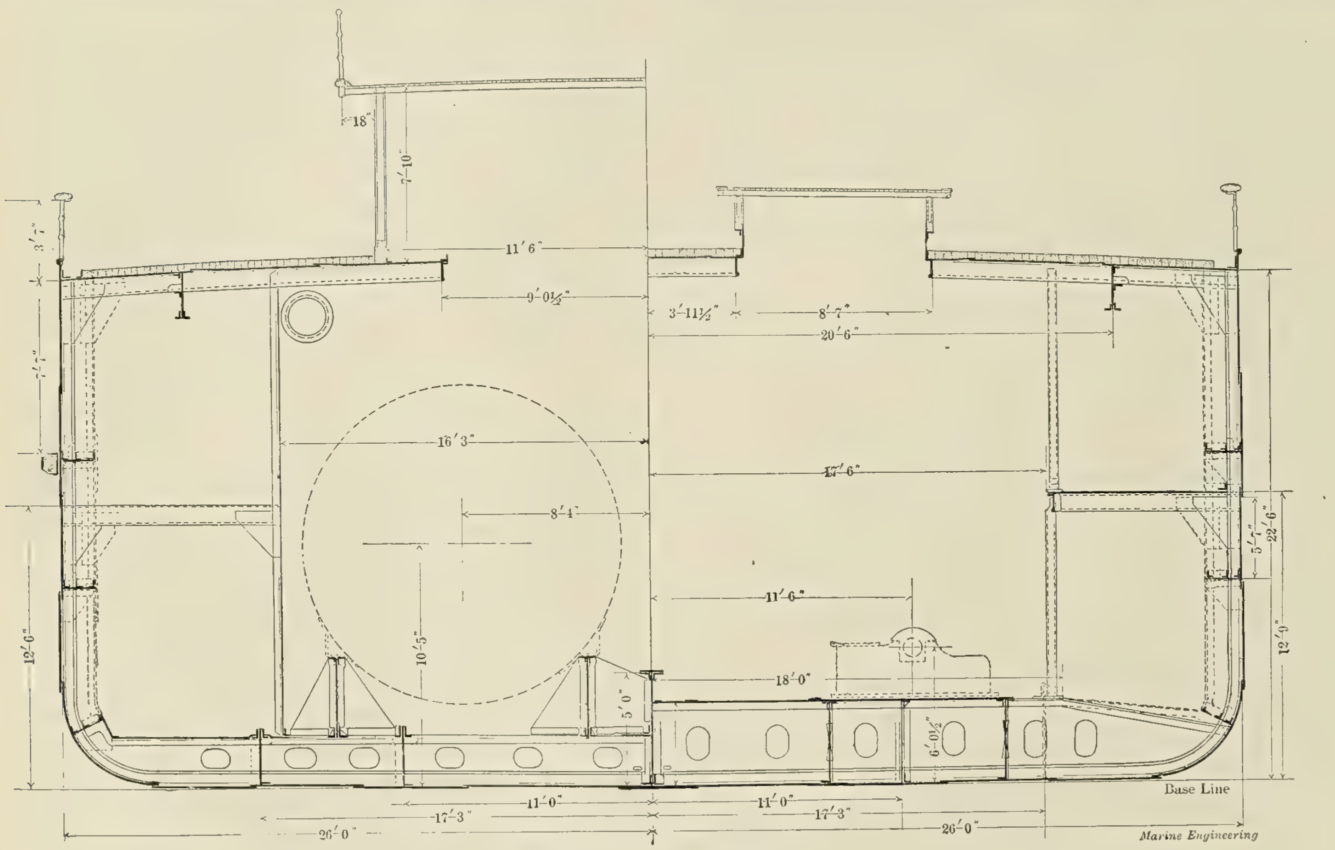
The hull is of mild steel throughout. The lower part of stem is cast steel and the upper part of rolled bar. The stern post is cast steel. The rudder is of single-plate type with forged stock and arms keyed. The extension stock is forged steel, bolted and keyed to palm on head of rudder stock. The frames are bulb angles, 7 inches by 3½ inches by 23 pounds, spaced 24 inches centers except at gates, where they are spaced 30 inches and 18 inches to accommodate same. At ends the frames are reduced to 21 pounds. Floors are 44 inches deep in way of bins and under engines, and 27 inches deep forward and aft of these spaces and under boilers. Under the engines the floors are plated on top, forming a feed-water tank. The reverse bars are fitted on top of floors only, extending from bilge to bilge continuous through center keelson. The center keelson is 60 inches by 25 pounds continuous, connected to flat-plate keel by double angles 6 inches by 4 inches by 20 pounds. Continuous angles of same size are fitted on top of floor stringers, which are 20 inches by 26 pounds to 20 pounds. At top of center keelson are double 6 inches by 4 inches by 20 pounds continuous angles with rider plate 12½ inches by ⅝ inch. There are two intercostals on each side, 25 pounds, flanged to shell and extending above floors, connected to double 6 inches by 4 inches by 20 pounds keelson angles. The bilge stringer consists of a 25-pound plate scored over frames with intercostal angle to shell. At the inside line of frames and inside line of plate are single continuous angles 4 inches by 4 inches by 12 pounds. One side stringer is fitted, consisting of an 18 inches by 25 pound plate with intercostal angle to shell and single angles at line of frame and inside line of plate.

The main-deck beams are bulb angles, 10 inches by 38 pounds, fitted on every frame. Tower-deck beams are bulb angles, 10 inches by 32 pounds, fitted on every frame forward and aft of bins. In wake of bins a built-up beam consisting of a 21 inches by 17½ pounds plate and double angles 3½ inches by 3½ inches by 8½ pounds is fitted to every frame except opposite center of gate openings, where a 10 inches by 32 pounds bulb angle is fitted continuously from side to side of ship to take gate-rod guides. The main deck is completely plated with wooden deck laid and calked. The lower deck is plated forward and aft of bins.

There are four watertight bulkheads: a forward collision; one abreast of forward bin; one between engines and boilers; and a stern-tube bulkhead. The coal bunkers are in the wings, extending full length of boiler space.

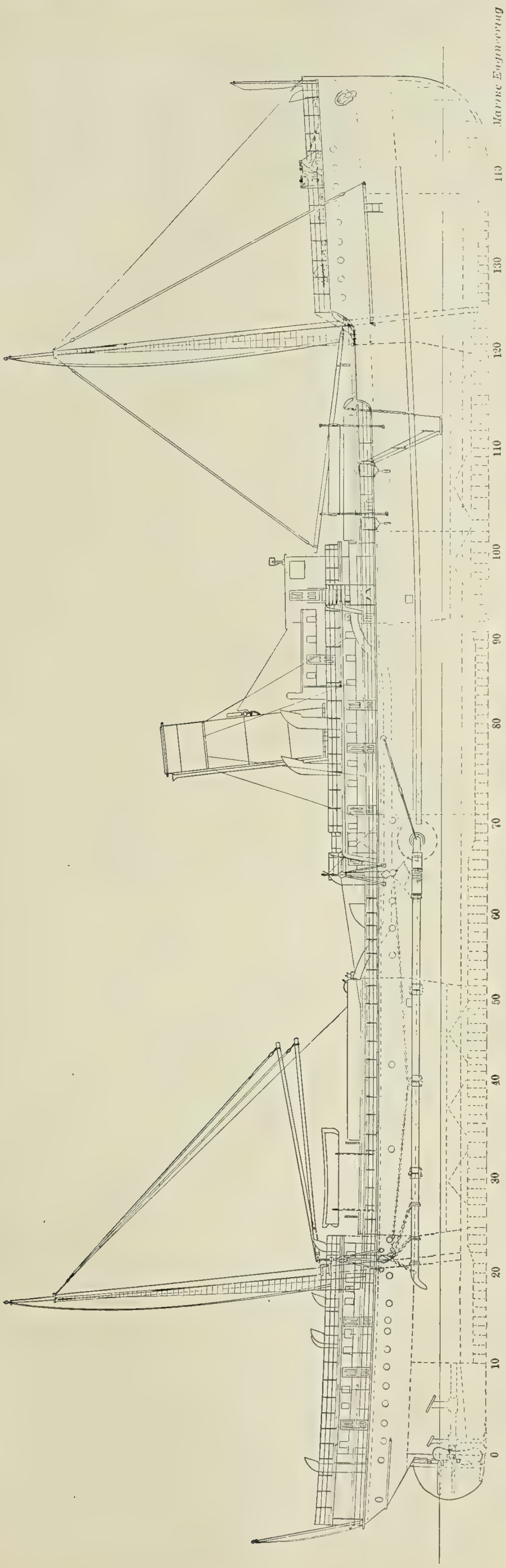
A forecastle deck is fitted, extending 50 feet from stem, with wood deck laid on same. Underneath are quarters for firemen and sailors, with toilets and separate galley. The windlass is on forecastle deck, with engines on same bed plate.

The sand bins are two in number, one forward and one aft of machinery space. The combined capacity is 2,200 cubic yards. The bulkheads forward and aft, and the side bulkheads, are well stiffened by bulb angles. In addition to these, large channel strong-backs are fitted to the end bulkheads, and heavy tie rods connect the forward and after strong-backs together. There are eight openings in each bin, with frames and gates of cast steel. The gates are so arranged that when open they are entirely above the lower edge of ship, which permits of dumping in shallow

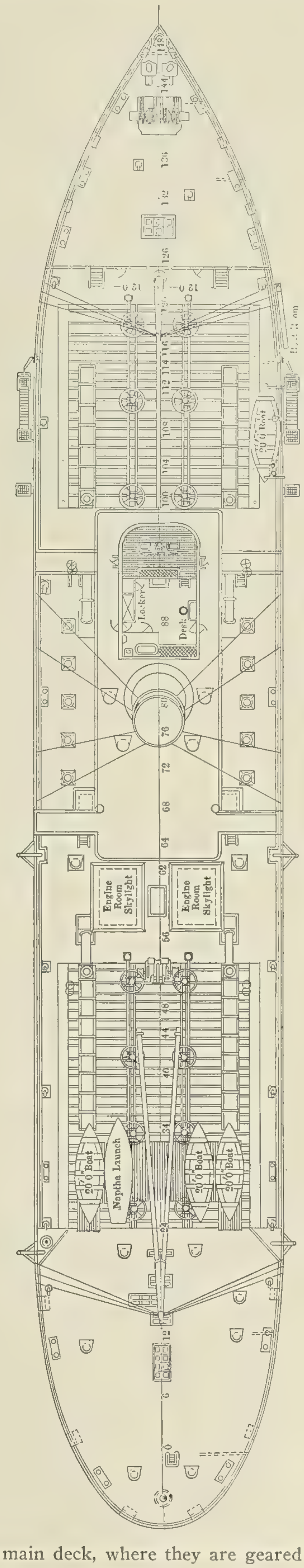


MIDSHIP SECTION OF DREDGE.

water. The bottoms of bins are fitted with hips, causing the sand to trim to openings. The gates are opened and closed by rods

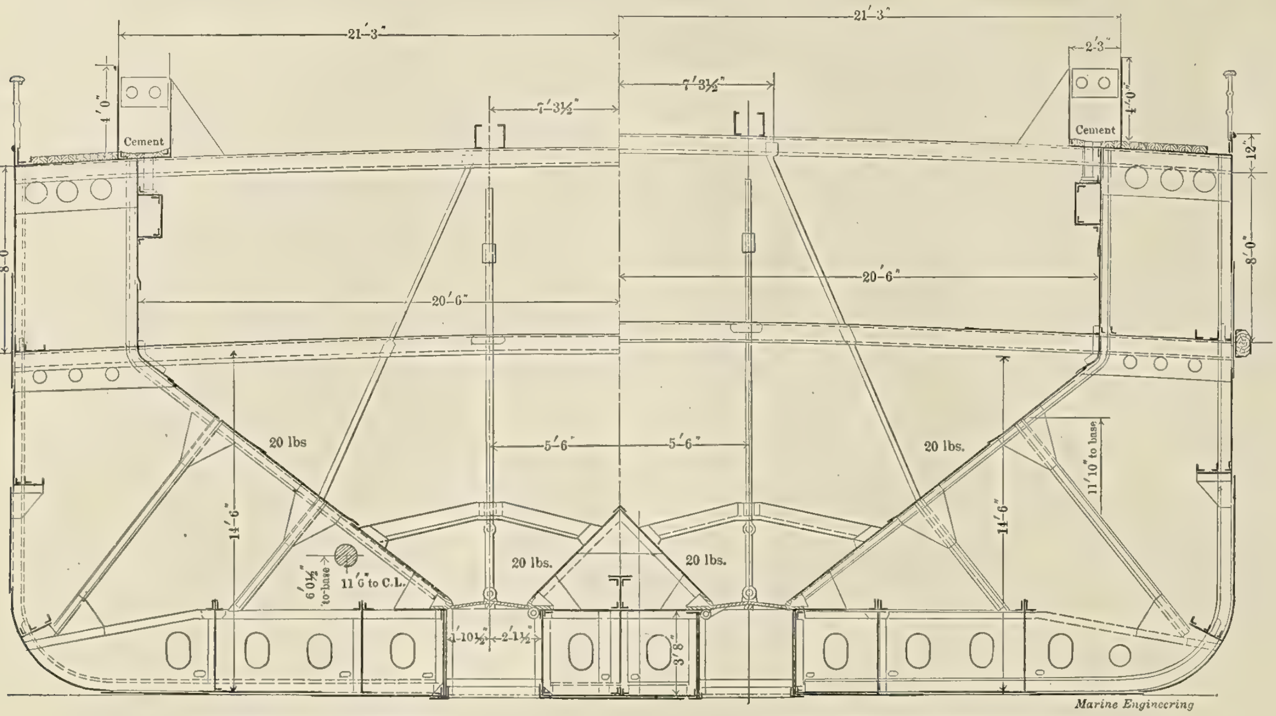


OUTBOARD AND PARTIAL INBOARD PROFILE OF SUCTION DREDGE, WITH RIGGING PLAN.



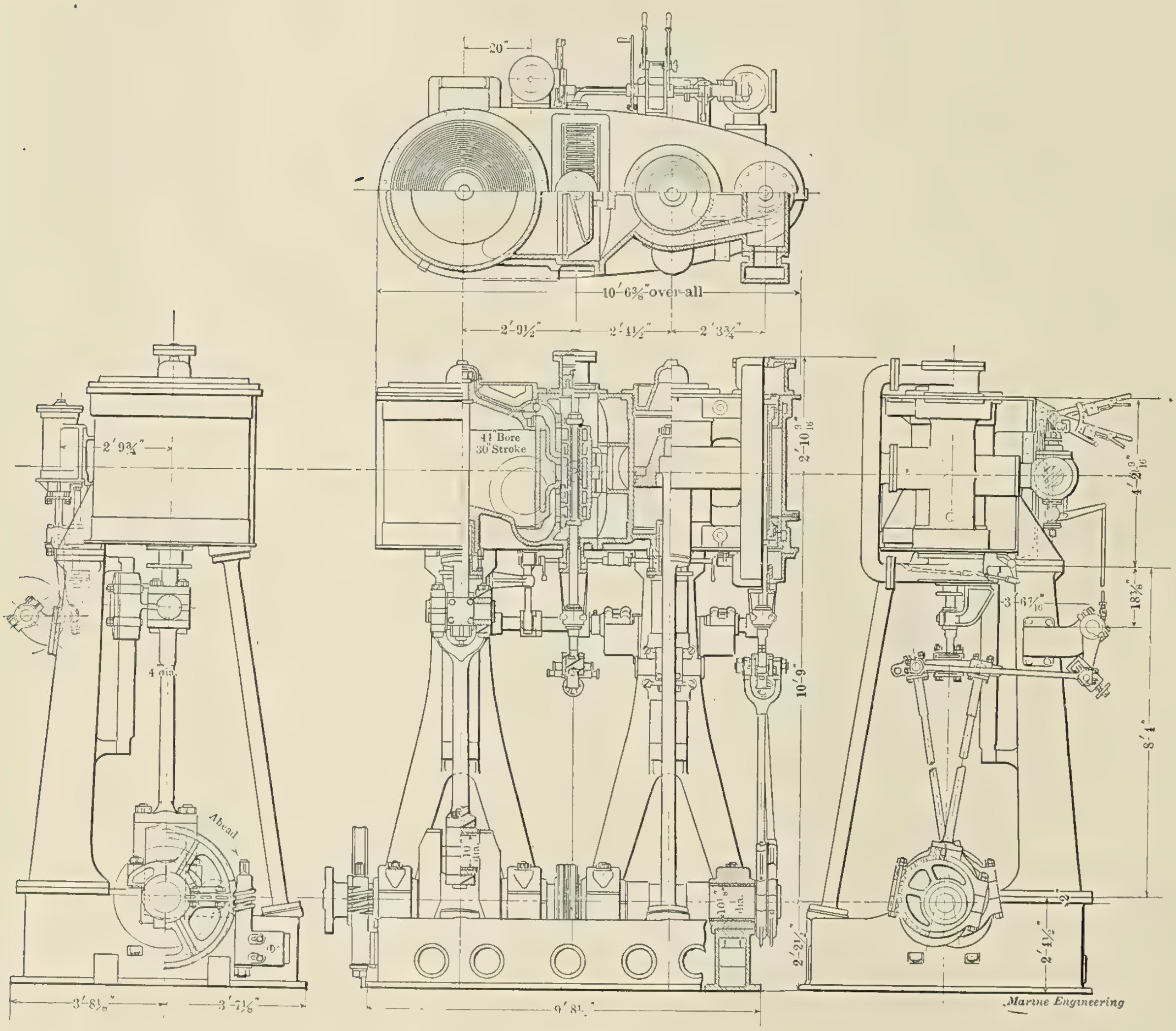
DECK PLAN OF SUCTION DREDGE FOR DELAWARE RIVER.

running above main deck, where they are geared to a continuous shaft, operated by a double 6- by 6-inch engine. There

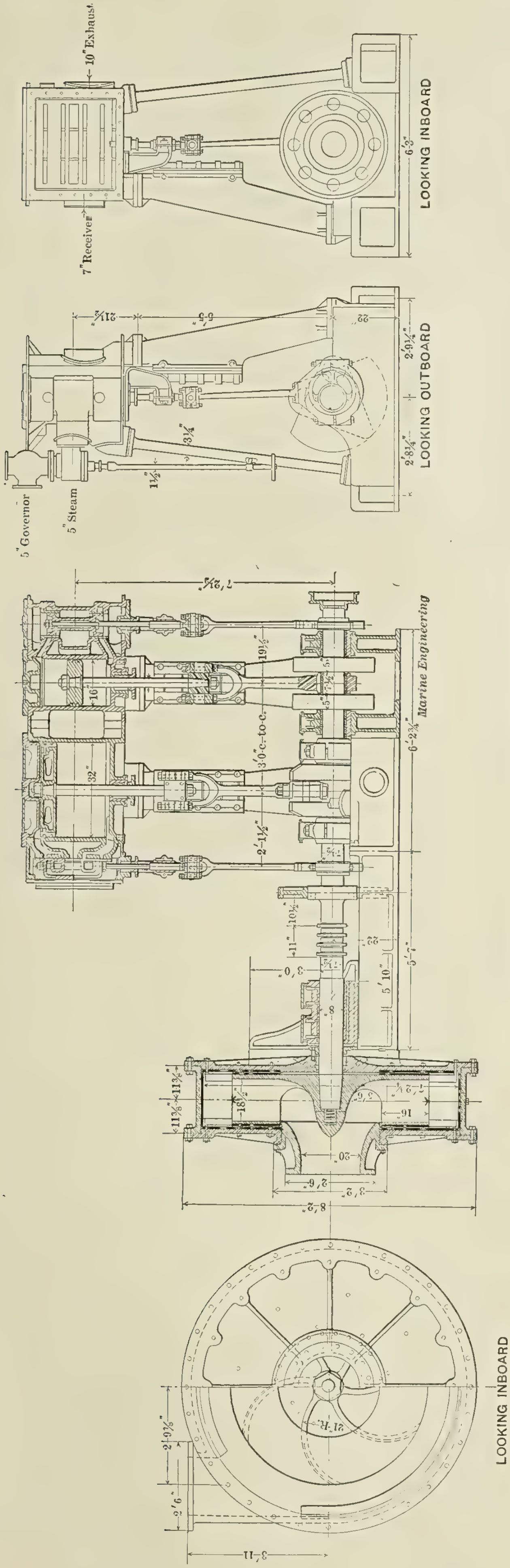


HALF SECTION AT AFTER BIN HALF SECTION AT FORWARD BIN

SECTION OF DREDGE, SHOWING HOPPER CONSTRUCTION.



PROPELLING ENGINE OF DREDGE.



CENTRIFUGAL PUMP AND ENGINE, DELAWARE RIVER DREDGE.

are four of these engines, two for forward bin and two for after one, each one operating four gates. A friction cone with spring is fitted at each gate rod, which localizes any irregularity which may occur in the time of closing the various gates.

The officers have quarters in deck house aft, and the captain in house on top of midship house. This house also contains pilot house. The midship house covers boilers and pumping engines, and in forward end has a machine shop and the steering engine. The officers' quarters are finished in selected cherry, paneled in captain's room. All have floors of oak.

Large skylights are fitted over the propelling engines.

Bridges extend to side of ship at forward and after end of midship house, for navigating and dredging purposes, and the throttle for engines and operating gear for valve in Y-pipe is operated from top of this house. The roof of after-deck house extends to rail, forming shade deck.

There are two masts, rigged schooner fashion, with one derrick boom on forward and two on mainmast.

Two winches are fitted on lower deck aft, with davits and falls for operating suction pipes.

The windlass and hoisting engines are made by the Hyde Windlass Company, Bath, Me., and the steering engine by Williamson Brothers, Philadelphia.

The compound propelling engines are two in number. The high-pressure cylinders are 22 inches and the low-pressure cylinders 44 inches in diameter; all of 30 inches stroke. The high-pressure cylinders are fitted with piston valves, and the low with double-ported slide valves. The valve gear is of Stephenson double-bar link type. The pistons are cast steel, with cast-iron followers.

The condenser is independent, of circular shape. The cooling surface is 4,011 square feet. An auxiliary condenser is also fitted for pumping engines, with 1,501 square feet cooling surface.

The air pump is twin-cylinder, vertical-duplex, double-acting, with steam cylinder 16 inches diameter and air cylinder 30 inches diameter, 18 inches stroke. The circulating pump is 12 inches diameter with 8- by 8-inch engine. The auxiliary circulating pump is 8 inches diameter with 6- by 6-inch engine. There are three boiler and bilge pumps, vertical-duplex, brass lined, 9 inches by 6 inches by 10 inches. The sanitary pump is vertical-duplex, 7½ inches by 4½ inches by 10 inches. An air-compressor pump of vertical-simplex type, 4½ inches by 5½ inches by 4½ inches, is connected to a 500-gallon pressure tank. The feed heater is supplied by the James Reilly Repair and Supply Company, New York. The fire pump is 14 inches by 8 inches by 12 inches vertical-duplex.

The two pumping engines are compound, with high-pressure cylinders 16 inches, and low-pressure cylinders 32 inches diameter, all of 18 inches stroke. The high-pressure cylinders are fitted with piston valves, and the low-pressure cylinders with double-ported slide valves. Each engine is direct connected to a 20-inch centrifugal pump built by the Ellicott Machine Company.

There are four Scotch boilers placed two forward and two aft, with thwartship fire room between. The boilers are 14 feet in diameter by 12 feet long, built for a working pressure of 125 pounds. Each boiler has three 42-inch Morison furnaces. The total grate surface is 280 square feet, and the total heating surface is 10,680 square feet, giving a ratio of 38.14 to 1. Natural draft is used.

The two propellers are 10 feet in diameter, 11 feet 6 inches pitch, of cast steel, solid wheels. The developed area of one wheel is 48 square feet.

The electric-light plant consists of two 25-Kw. generators direct connected to 7- by 9-inch engines. There are 220 16-candle-power lamps, 3 of 50 candle-power, and one searchlight of 35 amperes capacity on top of pilot house.

There are two 20-inch diameter suction pipes, one on each side of slip, with cast steel drags similar to that shown in our recent article on New York harbor dredges.

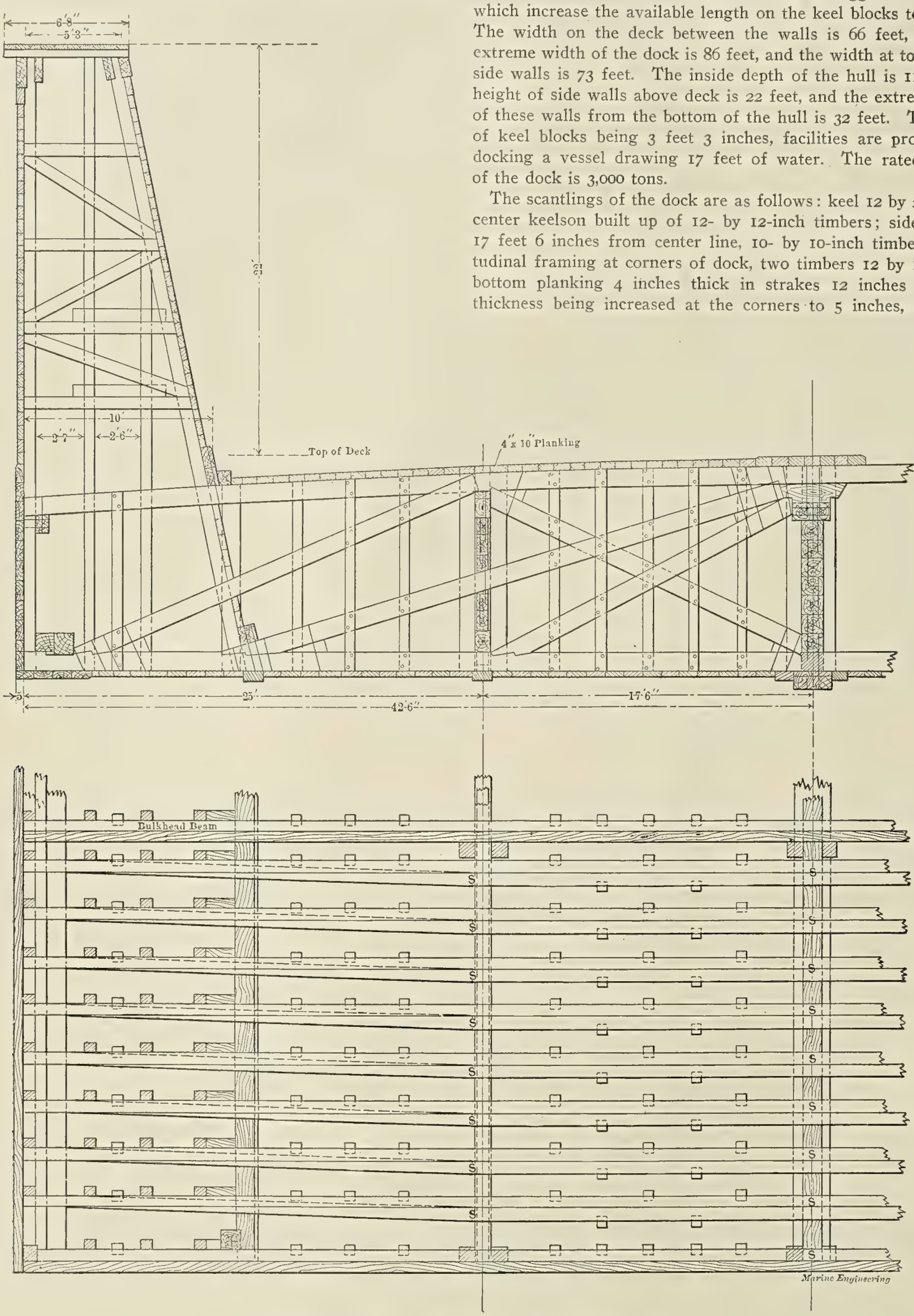
T. M. C.

A Wooden Floating Dry Dock at Mobile.

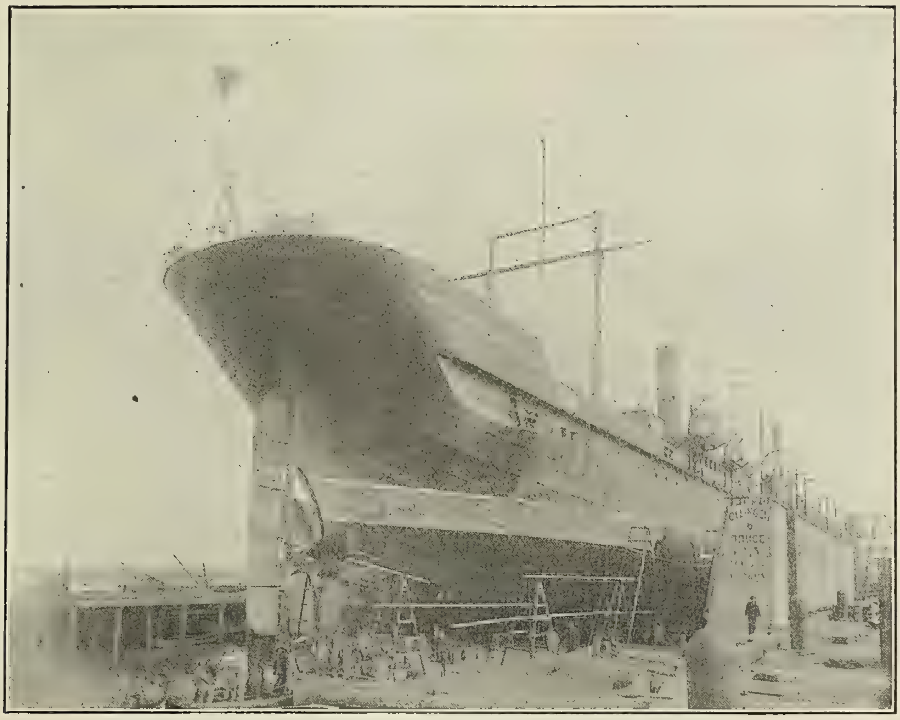
The rapidly increasing maritime importance of Mobile, with its many lines of freighters, lumber, cotton and cattle steamers, tramps and numberless schooners, has rendered it an absolute necessity to provide the port with a dry dock of sufficient capacity to take care of constantly recurring demands for general repairs. This long-felt need has now been met by the construction and putting into service of a floating dry dock built of wood by the Ollinger & Bruce Dry Dock Company, and operated by them.

The dock, of which we present a number of illustrations, has a length of hull of 232 feet, but there are outriggers at each end which increase the available length on the keel blocks to 312 feet. The width on the deck between the walls is 66 feet, while the extreme width of the dock is 86 feet, and the width at top between side walls is 73 feet. The inside depth of the hull is 11 feet, the height of side walls above deck is 22 feet, and the extreme height of these walls from the bottom of the hull is 32 feet. The height of keel blocks being 3 feet 3 inches, facilities are provided for docking a vessel drawing 17 feet of water. The rated capacity of the dock is 3,000 tons.

The scantlings of the dock are as follows: keel 12 by 24 inches; center keelson built up of 12- by 12-inch timbers; side keelsons 17 feet 6 inches from center line, 10- by 10-inch timbers; longitudinal framing at corners of dock, two timbers 12 by 12 inches; bottom planking 4 inches thick in strakes 12 inches wide, the thickness being increased at the corners to 5 inches, while one



HALF CROSS-SECTION AND PARTIAL PLAN OF MOBILE FLOATING DOCK.



STERN OF STEAMER OVERHANGING END OF DOCK.

(Photograph, Wm. E. Wilson.)

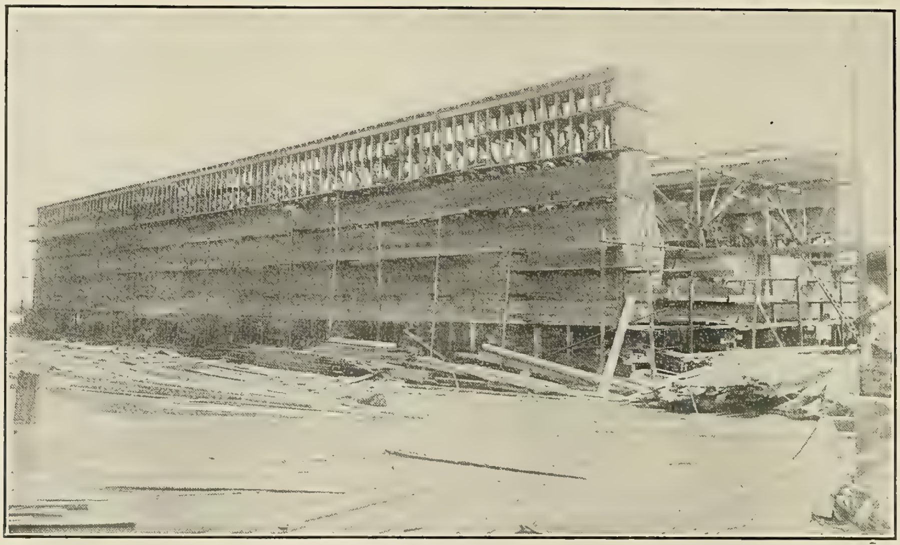
strake under the inside edge of side walls has a thickness of 8 inches; deck planking 4 inches thick in 10-inch strakes, increased to 8 by 12 inches under the keel blocks; side planking 5 by 12 inches to the level of the deck, and 3 by 8 inches on side walls above that level and upon top of side walls. Diagonal struts, measuring 8 by 12 inches, are run from the upper part of center keelson immediately under keel blocks to the base of intermediate side keelsons, and to the foot of inside edge of side walls, in each case being mortised into the 8- by 12-inch transverse bottom frames. Diagonals of this same size are also run from the top of intermediate side keelsons to the base of center-line keelson, and also to the lower corners of the dock, being mortised as in the other case. The deck beams are also 8 by 12 inches.

The vertical transverse and diagonal scantlings of the side walls are all 6- by 8-inch timbers.

Patent adjustable keel blocks are used throughout the dock. The fastenings are all of galvanized iron. The splendid qualities of long-leaf southern yellow pine, together with the long lengths obtainable, rendered this material an ideal one for the construction of the dock. All of the timber entering into the

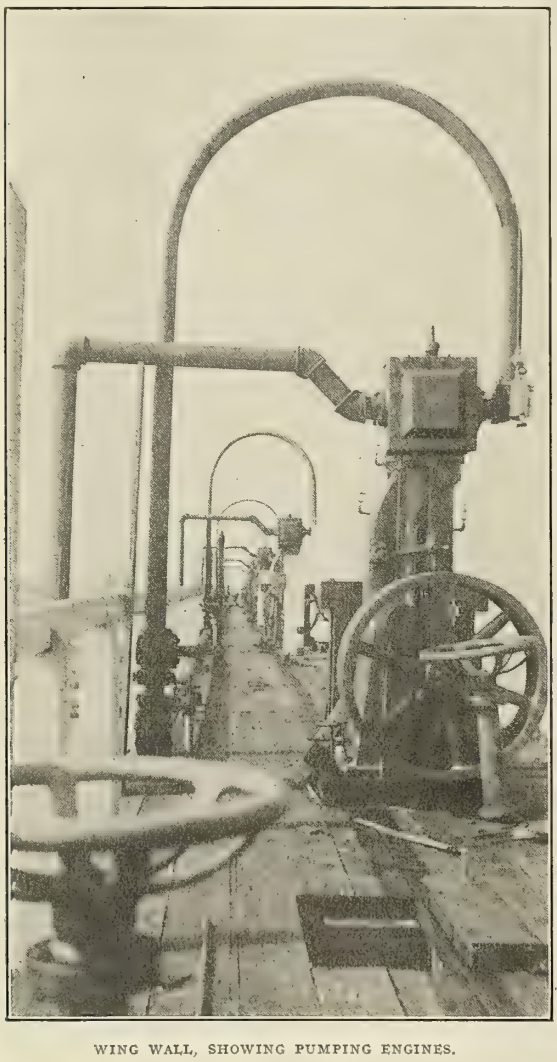
STEAMSHIP TAUNTON IN MOBILE DOCK.

(Photograph, Wm. E. Wilson.)



THE DOCK UNDER PROCESS OF CONSTRUCTION.
(Photograph, Wm. E. Wilson.)

construction was treated with timber preservatives before being used. A very complete pumping system has been installed, consisting of ten 13-inch centrifugal pumps, each operated by a separate upright engine, as shown in one of our photographs. The pumping system was installed by the Bolander & Schwind Company, of New Orleans. Two large safety water-tube boilers furnish the necessary steam for the pumps, under a maximum working pressure of 150 pounds per square inch. They were



WING WALL, SHOWING PUMPING ENGINES.

furnished by the Ivans Company, of St. Louis. Patent swivel joints are used in connection with the 8-inch steam-supply pipes.

The capacity of the pumps is three million gallons per hour. The engines are situated on the top of the side walls and are geared direct to the pump shaft, while the steam for them is supplied by the boiler plant on shore at the head of the slip.

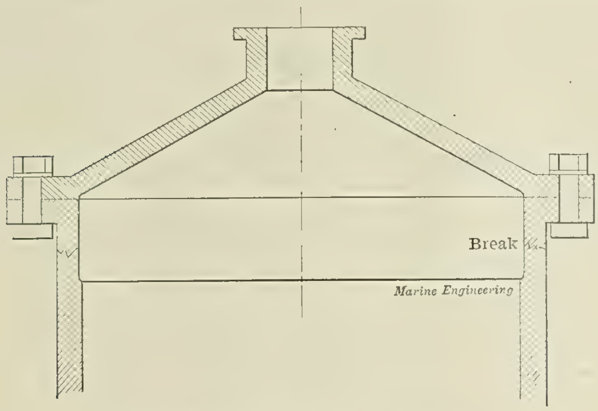
The slip in which the dock is permanently located was dug out of a solid sand bank, and in the process of preparing it it was found necessary to use large quantities of dynamite to remove the old wrecks of defunct steamboats found buried on the site. Two of our illustrations show vessels on the dock, and in one case it will be noticed that the ship overhangs the length of the dock by a considerable amount. This ship, which is the *E. O. Saltmarsh*, of London, measures 3,230 tons gross, 2,312 tons net, has a length over all of 350 feet, a beam of 50 feet, extreme depth 32 feet, and a displacement at the time of docking of 2,600 tons. This vessel was lifted out of the water until the dock had 15-inch freeboard at lowest point of deck line in thirty minutes after being located on the blocks.

The plans of the dock were drawn by the builders from plans of a smaller dock owned by the Tietjen & Lang Dry Dock Company, Hoboken, and the dock was constructed under the general superintendence of Mr. Charles N. Crowell, of Orange, Texas.

Rapid Repair Work on the Majestic.

When the steamship *Majestic*, of the White Star Line, came limping into New York harbor early in July under her port engine, with the starboard engine room a mass of wreckage, it was thought that a very considerable time must elapse before the ship could again be put into service. The breakdown was due to the fact that the crosshead pin on the intermediate cylinder of the starboard engine had broken, allowing the connecting rod to wreck the back housing of the frame, while the piston on the next stroke jumped up through the top of the cylinder, tearing off the cylinder head by rupturing the barrel just below the upper flange, as shown in the sketch. The cylinder head bolts held tight, so that the upper flange and cylinder head were thrown off in one piece.

It was discovered upon further examination that the high-pressure and low-pressure engines had not been seriously disturbed, and under the direction of Mr. Barber, chief engineer of the *Majestic*, the wreckage was cleared away and temporary repairs made by Alexander Reid, engineer, of New York. These repairs consisted in the main in removing the steam connections between the high and intermediate cylinders, and between the intermediate- and low-pressure cylinders, and substituting a 36-inch copper pipe 3/8 inch thick, running from the exhaust openings of the high-pressure valve chest to the steam opening of the low-pressure valve chest. This work was performed so expediciously that although the *Majestic* was two days late getting into port, on account of the delay caused by the breakdown, she sailed on time, using the port engine triple expansion and the starboard engine as a compound.



SKETCH SHOWING BREAK IN CYLINDER.

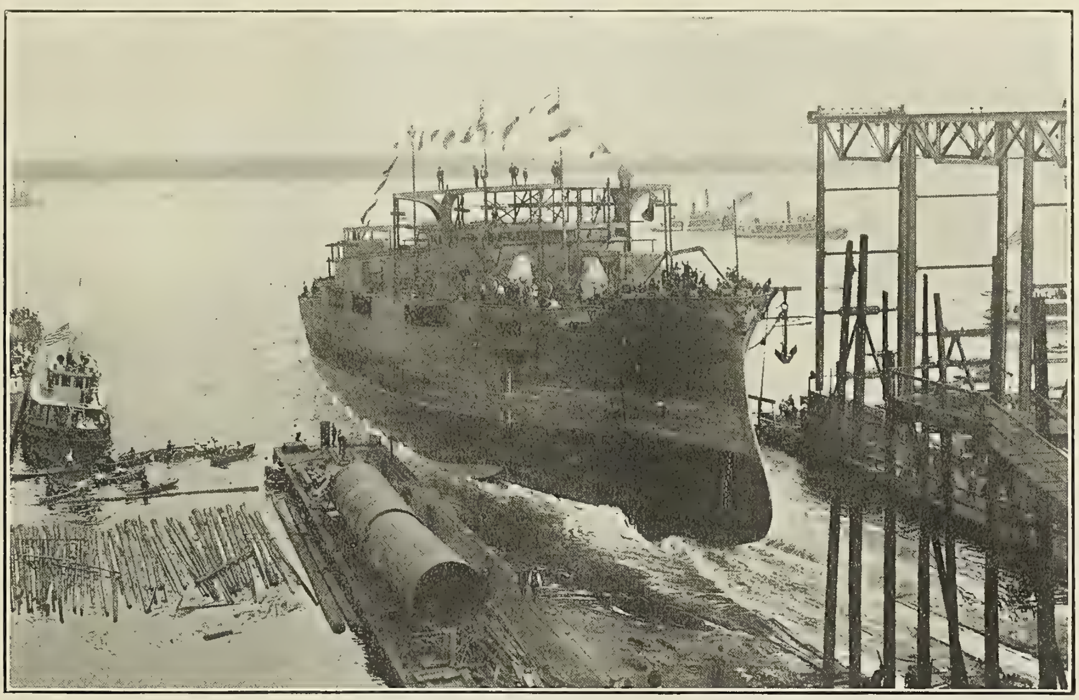
Arriving at her destination in England, the *Majestic* was placed in charge of Messrs. Rollo & Sons, of Liverpool, for permanent repairs, and although it was found necessary to practically reconstruct the intermediate-pressure engine, involving in all the casting and machining of more than forty-five tons of material, yet this contract was taken with a promise to deliver the ship for trial trip in six and a half weeks from its date. The castings were started under the supervision of Mr. Willet Bruce, superintending engineer of the line, before the arrival of the *Majestic*, from measurements taken from the engines of her sister ship *Teutonic*, and, as a result, the *Majestic* was enabled to make her next trip after having missed only one round trip between England and the United States.

This record is a splendid one for the engineers at both ends of the line, and one of which they may well be proud.

Thirteenth Annual Meeting of the Society of Naval Architects and Marine Engineers.

An unusually interesting list of papers is promised for the coming general meeting of the Society of Naval Architects and Marine Engineers, to be held in New York, November 16 and 17, 1905. The list is not yet complete, and it will be noticed that two of the papers mentioned have not yet been outlined. The list, as it stands at the present time, is as follows:

1. Investigations Relating to the Action of Screw Propellers. By Professor Wm. F. Durand, Member of Council.
2. Progressive Speed Trials of Gasoline Launch Ludo. By George Crouse Cook, Member.
3. Some Results of Tests of Model Propellers. By Messrs. A. V. Curtis and L. F. Hewins, Juniors.
4. Experiments with Ventilating Fans and Pipes. By Naval Constructor D. W. Taylor, U. S. N., Member of Council.
5. Notes on the Strength of Water-tight Bulkheads for Battleships and Cruisers. By Harold F. Norton, Associate.
6. A Tale from Japan. By Mr. George W. Dickie, Member of Council.
7. Marine Steam Turbine Developments. By Mr. E. M. Speakman, Associate.
8. Some Problems in Ferry Boat Propulsion. By Colonel E. A. Stevens, Vice-President.
9. The Ultima, a Globuloid Naval Battery. By Anson Phelps Stokes, Associate.
10. The Cruiser. By Commander Wm. Hovgaard, Member.
11. Scantling Regulation in Yachting. By W. P. Stephens, Associate.
12. Some Notes on Steam Boiler Troubles. By Horace See, Member of Council.
13. Yacht Races. By Paul Eve Stevenson, Esq.
14. Shipbuilding of the Great Lakes. By W. I. Babcock, Member of Council.
15. ————————. By Clinton H. Crane, Associate.
16. Marine Turbines. By Charles G. Curtis, Member.
17. ————————. By Naval Constructor H. G. Gillmor, Member.



THE MISSISSIPPI ENTERS THE DELAWARE.

(Photo. W. H. Rau.)

ANOTHER BATTLESHIP LAUNCHED.

On September 30, the new battleship *Mississippi* was launched from the yard of the William Cramp & Sons Ship and Engine Building Company, of Philadelphia. The launching ceremony was performed by Miss Mabel Clare Money, daughter of United States Senator H. D. Money, of Mississippi.

The *Mississippi* is one of two sister ships, the other being the *Idaho*, authorized by act of Congress approved March 3, 1903, and is the result of a compromise; one party in Congress was in favor of building 16,000-ton ships, while another party favored smaller ships, of a displacement not to exceed 12,000 tons. The compromise was effected by the authorization of three ships of 16,000 tons, now known as the *Minnesota, Vermont,* and *Kansas,* all three of which have been launched, and two of 13,000-tons, of which the present is one. The contract for the construction of the *Mississippi* was signed January 25, 1904, the price for hull and machinery being $2,999,500, and the contract date of completion March 25, 1907, this being thirty-eight months from date of contract. The keel was laid May 12, 1904, so that a period of sixteen months and eighteen days has elapsed between laying the keel and putting the ship into the water. According to the monthly report from the Bureau of Construction and Repair, the *Mississippi* has now reached a stage of completion represented by about 43 percent.

The ship has a water-line length of 375 feet, a beam of 77 feet, and a normal draft of 24 feet 8 inches, the length over all being 382 feet. The displacement on trial, with a load including 600 tons of coal, is to be 13,000 tons, at which the engines, designed to develop 10,000 horsepower, are expected to give a speed of 17 knots. With the full bunker capacity of 1,750 tons of coal and full stores and ammunition on board, the displacement becomes 14,465 tons. The machinery consists of twin-screw, triple-expansion engines, with cylinders measuring respectively 25½, 42 and 69 inches in diameter and a common stroke of 48 inches. These engines are operated by steam furnished by eight Babcock and Wilcox boilers, with a total grate surface of 768 square feet and heating surface of 32,640 square feet, this giving a ratio of 42.5 to 1. The estimated steaming radius at ten knots is 5,750 nautical miles.

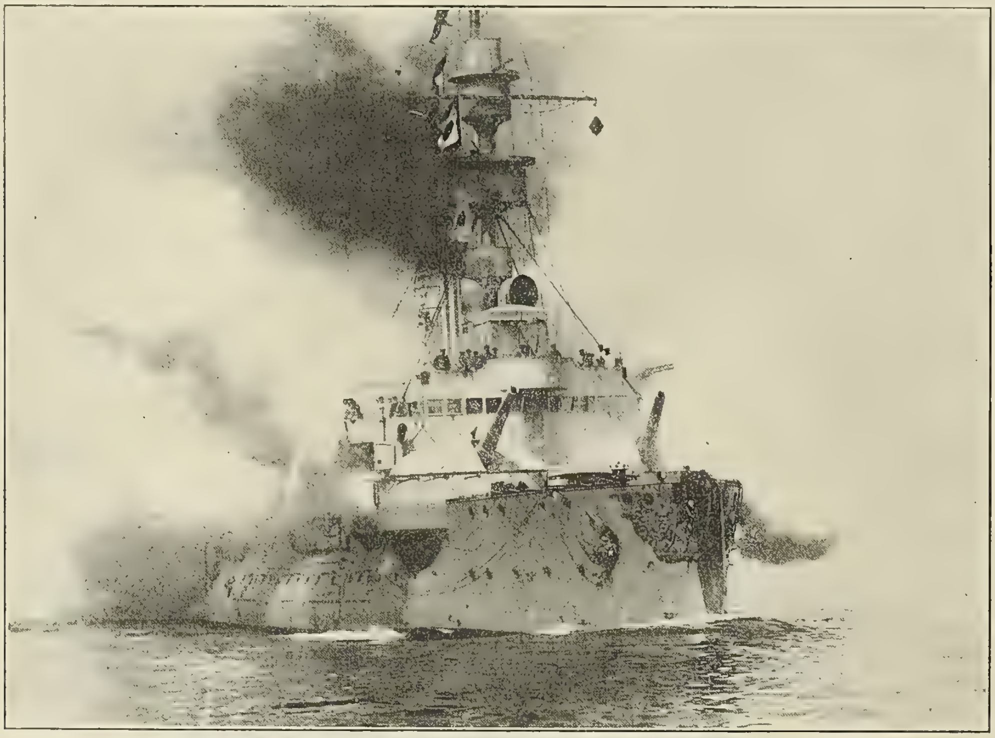
The *Mississippi* is one of the most powerfully armed battleships afloat, and is without exception the most powerful of her size. The main battery consists in four 12-inch and eight 8-inch breech-loading rifles, mounted in pairs in six turrets; the 12-inch guns being on the center line forward and aft, and the 8-inch guns at the four corners of the citadel on the main deck. In addition to these, there are eight 7-inch rapid-fire guns mounted behind 7-inch armor on the broadside, and a secondary battery consisting of twelve 3-inch, six 3-pounder, four 1-pounder rapid-fire guns, two 3-inch field guns, and eight automatic machine guns, together with two 18-inch torpedo tubes of the submerged type.

The protection includes a complete water-line belt, having a thickness amidships of 9 inches and tapering to 4 inches at the ends. The turrets for the 12-inch guns have a thickness on the exposed side of 12 inches and on the rear of 8 inches, while the corresponding thicknesses of the 8-inch turrets are 6½ and 6 inches. The barbettes for the heavy guns are 10 inches on the exposed side and 7½ in the rear, with corresponding figures for the 8-inch guns of 6 and 4 inches. A complete protective deck is fitted, measuring 1½ inches on the flat and 3 inches on the slopes. The crew will consist of 34 officers and 691 men.

German Coast Defense Ships.

We are presenting a reproduction of a photograph showing one of the German armored coast-defense ships of the *Siegfried* class in the act of thundering a salute. It will be noticed that the powder used is not of the smokeless variety.

The *Siegfried* belongs to a class of eight ships, the first of which was launched in 1889, and the last in 1893. These ships were all rebuilt three or four years ago and in process of rebuilding were lengthened. The original dimensions were 239 feet in length, 49 feet in beam, and 18 feet draft, giving a displacement of 3,496 tons, the block coefficient being 0.581. The new dimensions are 254 feet in length, with the same beam of 49 feet, and a draft of 18 feet 3 inches. This gives a displacement of 3,876 tons with a block coefficient of 0.588. The increase in size has enabled the ships to carry 500 tons of coal, as against 225 tons under the original form, has slightly increased the speed, and has admitted a slight increase in the battery. The offensive power is furnished by three 24-centimeter (9.45-inch) guns, 35 calibers long, mounted in three separate barbettes, of which two are side by side forward, while the third is on the center line aft; ten 8.8-centimeter (3.43-inch) rapid-firing guns, 20 calibers long, in place of eight such guns on the original ships; six smaller guns; and four torpedo tubes, of which one is above water aft, and is protected by armor, while three are submerged, one being under the bow and one on each side.



THE SIEGFRIED FIRING A SALUTE.
(Photograph, George P. Hall & Son.)

The designed power of the original ships was 4,800 I. H. P. with a speed of 15 knots. This was furnished by two sets of triple-expansion engines operating twin screws and supplied with steam from cylindrical boilers. Since reconstruction one of the ships, the *Hagen,* has developed 5,235 horsepower on trial with a speed of 15.1 knots at 142 revolutions per minute. The steaming radius figures out at 3,500 miles, at a speed of 10 knots, while the tactical turning diameter, at a speed of 12 knots, proves to be 400 meters, or 432 yards.

The ships are furnished with compound armor, having an armor belt about 7 feet wide with a maximum thickness amidships of 9.45 inches, which is diminished at the ends to 6 inches. There is a flat armored deck having a thickness of 1.2 inches, while the barbettes for the heavy guns and the hoods for the guns are respectively 7.9 inches and 5.3 inches thick.

The eight ships of the class are named as follows: *Siegfried, Hagen, Beowulf, Frithjof, Heimdall, Odin, Ægir,* and *Hildebrand.*

Service Speed Trial of Battleship Ohio.

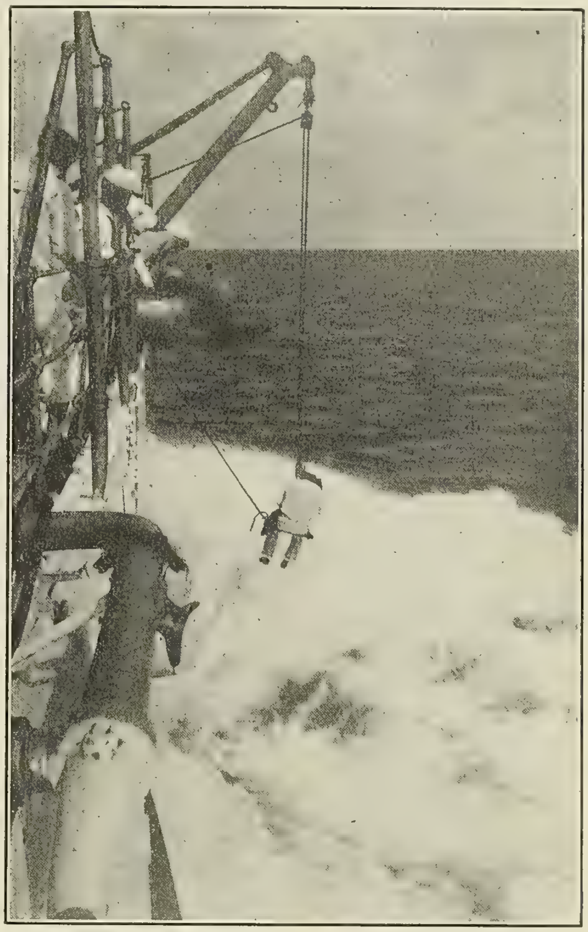
On July 30, 1905, the first-class battleship *Ohio,* which is attached to the Asiatic squadron, was given a natural-draft speed trial, lasting from 1 to 5 o'clock in the afternoon, during which the speed realized averaged 16.8 knots by patent log, 16.6 knots by observations of positions of ship at beginning and end, and 17 knots as computed from the speed-power curve of the ship. This was the regular quarterly trial called for by the navy regulations, but was at the same time a race in which the battleships *Wisconsin* and *Oregon* were also involved. The *Ohio* is said to have been sixteen miles ahead of the *Wisconsin* at the finish, while the *Oregon* was out of sight in the rear. The Pocahontas coal used was reported to be of good quality, but as a matter of fact it was mostly slack, due to a low supply. The blowers were run simply for ventilating purposes, and at a very low rate of revolution. It is thought that had the coal been really of first quality, and the blowers run to their full capacity, the result would have exceeded in speed that obtained upon the builders' trial trip, namely, 17.83 knots. The mean depth of water varied from 15 to 38 fathoms.

During the trial a number of photographs were taken, and especially interesting is one which we publish, showing a man in the act of taking a photograph of the bow wave while being himself suspended with his camera from the starboard anchor crane.

Trial data follow:

		STARBOARD	PORT
Steam at boilers		186	
Steam at engines		183	
Steam at first receiver ... pounds		78	83
Steam at second receiver ... pounds		28.8	30.0
Vacuum ... inches		24.8	25.6
Cut-off		Full	Full
Throttle		Wide	Wide
Mean effective pressure	H.P.	66.7	55.5
	I.P.	37.1	35.9
	F.L.P.	14.0	14.3
	A.L.P.	13.5	14.7
Revolutions per minute		115.7	115.5
Indicated horsepower	H.P.	1,808.67	1,506.94
	I.P.	2,252.14	2,204.96
	F.L.P.	1,218.85	1,243.16
	A.L.P.	1,155.86	1,278.56
	Total,	6,435.52	6,233.62

Total horsepower main engines	12,670.
Auxiliaries' horsepower ... estimated	280.
Collective indicated horsepower	12,950.
Square feet heating surface	53,253.
Square feet grate surface	924.
Indicated horsepower per square foot grate surface	14.01
Square feet heating surface per indicated horsepower	4.11
Coal per hour ... pounds	21,760.
Coal per indicated horsepower per hour ... pounds	1.68
Pounds coal per square foot grate surface	23.5
Temperature of engine room ... degrees	98.
Temperature of fire room ... degrees	120.
Temperature injection water ... degrees	75.
Temperature discharge water ... degrees	122.
Temperature feed water ... degrees	166.
Draft forward	24' 6"
Draft aft	24' 2"
Mean draft	24' 4"
Displacement corresponding to mean draft ... tons	13,000.



PHOTOGRAPHING THE BOW WAVE OF THE OHIO.

The Bureau of Navigation, of the Department of Commerce and Labor, reports that there were built in the United States during the quarter ended September 30, 1905, 315 ships of a total of 82,520 tons. Of this total 31 ships of 68,880 tons were built of steel and the balance of wood. Of the steel ships 27, of 66,329 tons, are propelled by steam. In the latter class are 14 ships on the Great Lakes, aggregating 54,845 tons, or about two-thirds of the grand total of all ships built during the quarter. The total compares with 328 vessels, of an aggregate of 40,374 gross tons, built during the corresponding quarter of 1904.

Lloyd's Register reports under construction in the United Kingdom on September 30, 1905, a total of 474 merchant ships of an aggregate of 1,325,328 gross tons, of which 446 of 1,320,098 tons are propelled by steam and the balance by sail; in the former class all but two ships are of steel. These figures compare with a total of 393 ships of 1,046,308 tons on the same date one year ago. Of the ships included in the above totals, no less than eleven are of 10,000 tons and upward, of which five reach 20,000 tons and three others 15,000 tons.

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The edition of the November issue of Marine Engineering comprises 5,500 *copies. We have no free list, accept no return copies and issue only enough to supply the regular demand, so that the* 5,500 *copies represent legitimate circulation.*

We have now no engineer corps, though we used to have the best in the world.—Melville.

The Merchant Marine.

We publish in another column a masterly dissertation on the subject of the American Merchant Marine from the lips of Mr. George W. Dickie, late manager of the Union Iron Works of San Francisco. This address was delivered during the exposition in Portland, Ore., and gives a splendid idea of the difficulties with which American shipbuilders have to contend in competing with those across the water. The table presented, showing differences in cost of labor between the Union Iron Works and a dozen representative yards in Great Britain, illustrates the great controlling factor in the problem, speaks volumes for the tremendous handicap endured by our shipbuilders, and makes it plain why we have been able to do so little in the matter of building up our merchant marine. It is a fact that since the contracts were let for the construction of the Great Northern steamships *Minnesota* and *Dakota,* which occurred in June, 1901, there has not been obtained by any American shipbuilder an order for any merchant ship of any importance for use in transoceanic trade, except as between non-contiguous parts of the United States. In direct contrast with this state of affairs, it may be stated that during the month of September shipbuilders on the Clyde alone booked orders for 100,000 tons of shipping, while 40,000 tons of new ships intended almost entirely for foreign service were launched during that month. During the quarter ending September 30, 1905, the merchant shipping placed under construction in the United Kingdom amounted to about 374,000 tons, while there were launched during the same period ships aggregating 419,000 tons. Another indication of the tremendous decadence of our shipping is evidenced by the fact that during the first week in October there arrived in the port of New York thirty-five steamers from Great Britain and the mainland of Europe, only one of which was under the Stars and Stripes. Of the remainder, fifteen were British, six German, four Italian, three French, two Danish, and one each from Norway, Holland, Portugal, and Austria-Hungary. There is not a single one of these nations which has so great an export trade of domestic products as has the United States, and, with the sole exception of Great Britain and Germany, not one has so large an import trade; and yet with an enormously smaller volume of business to be transacted, these other nations are able to send into the chief port of the United States ships in much larger number than those which the United States can maintain, and thereby take care of upward of ninety percent of our ocean-going commerce.

There is nothing in the shipbuilding art itself which would make it of necessity a non-paying industry; and when it is removed from competition with inferior conditions of labor, as is the case with our shipbuilding on the Great Lakes, large profits are obtained. The annual report of the American Shipbuilding Company shows that during the year ending June 30, 1905, the net earnings of this corporation, after deducting all operating expenses from gross earnings, amounted to $1,550,000. Deductions for depreciation and maintenance of plants and rebuilding in a number of cases reduced the figure to about $1,200,000, which was thereby made available for dividends. After these dividends had been paid, there remained a surplus for the year of $640,000. This was added to a previous surplus of $3,680,000, giving a total surplus at the present time of more than $4,300,000. This is pretty good evidence of a healthy condition, and a condition which could be reasonably expected to obtain upon the Atlantic and Pacific seaboards, were it possible to withdraw the industry on those coasts from direct competition with the cheap labor of Europe. It is beyond all question that it will be utterly impossible for us to meet that labor in kind by debasing the condition of American labor to that represented by the wages received on the other side of the water; and the only alternative, if we are to build ships for foreign service, is to make some provision, whether by subsidy or otherwise is immaterial, looking to the protection of that industry in the same manner and in the same degree as nearly all other industries in the United States are protected. Theorists may differ on the general value of protection from the point of view of political economy, when considered in the abstract, but there can be no difference of opinion whatsoever upon a subject such as the present, where it is found that protection for internal industries has resulted in raising prices of labor and improving conditions of living to such an extent as to make it impossible to continue a single industry *outside the barrier of the protective tariff* with any chance of making it a profitable undertaking.

At the thirty-first annual meeting of the American Bankers' Association, which was held in Washington during the month of October, Hon. Leslie M. Shaw, Secretary of the Treasury, addressed the association upon this subject, and we quote as follows from his address:

"We point with pride to our export trade of a billion and a half, and with our thumbs in the armholes of our waistcoats we contemplate our skill and foresight and our ability as international merchants. Will I be pardoned if I suggest that this export trade is due in no very large degree to our skill either as international bankers or as international merchants?

"Of our aggregate exports, about $1,000,000,000 consists of raw cotton, food products, petroleum products, crude copper, lumber and other raw materials and crude articles, of which we produce a surplus which the world not only needs but must have.

"The time is coming, gentlemen—with our increasing population more largely urban than ever, with factories multiplying more rapidly than farms, with limitless manufacturing resources and matchless aptitude for production—when the United States will need new and important markets. The world may come to us in its own ships for the products of our farms and the raw products of our mines, but it will not come in its own ships for the finished products of our factories. The time is coming when we will need international bankers and international merchants and an international merchant marine.

"I am well aware that this is not supposed to be a popular theme, but I did not accept your courteous invitation for the purpose of discussing subjects on which all good men agree. I accepted for the purpose of bringing to your consideration questions which public speakers usually avoid, to the end that you may think them over, talk them over by your firesides and in your places of business, in the hope that we may some time, and as soon as possible, agree upon some course, some policy, that will restore our flag to her deserved place on the seas and give to American enterprise its share of the carrying trade of the world.

"We occupy the best position on the map. We have the safest and most convenient form of money in the world. We speak the language of commerce. Our farms produce more than the farms of any other country. Our mines yield gold literally by the car-load, silver by the train-load, and there is unloaded on the shores of a single commonwealth more iron ore than any other country produces. Our forests yield one hundred million feet of lumber for every day of the calendar year. Our factories turn out more finished products than all the factories of Great Britain and Germany combined by more than three thousand millions every twelve months. We transport this matchless product of farm and factory, forest and mine, from the interior to the sea at one-third what similar services cost anywhere else beneath the skies. We carry it from point to point along the coast in better vessels, on quicker time, and at cheaper rates than others.

"But at our coast line we are brought to an abrupt halt. Here we are no longer independent. Our foreign commerce is four times as large as forty years ago, but we carry in our own ships only one-third as many gross tons as forty years ago. We have protected and encouraged every interest but our merchant marine, and every protected interest has flourished. We have every facility for international commerce except international merchants, international bankers, and an international merchant marine. Shall we not have these? I am not urging ship subsidies. I am speaking of results, not of methods. If we will but take advantage of our opportunities we will send these products of farm and factory under every sky and into every port, and make our financial centers the clearing houses of at least a fraction of the world's trade."

At the conclusion of the meeting the twenty-five hundred bankers in attendance passed a resolution introduced by Colonel Robert J. Lowry, of Atlanta, Ga., which read as follows:

"Resolved, That the members of the association are deeply interested in any measure which will promote the interests of the whole country, industrially and commercially, and especially with reference to our foreign commerce.

"That we favor and most respectfully urge the passage by congress of some measure to foster and encourage the upbuilding of the merchant marine and give us back the prestige on the high seas which we once enjoyed.

"That we favor the ship subsidy measure, which has received consideration at the hands of our congress, and which we think would tend to restore our flag upon the seas and build up our merchant marine to the extent that the necessities of our trade now and in the future may demand.

"That we recommend that our senators and representatives favor some just and equitable measure that will bring about the results and afford the relief above suggested.

"That through our legislative committee we memorialize the senate and house of representatives of the United States with a copy of these resolutions."

This, taken in connection with similar action by other associations in the recent past, shows the growing conviction which we mentioned above, and as the movement seems to be spreading all over the country, and to be confined to no one section, not even to the seaboard section, it seems as if some action by congress could reasonably be expected at an early date. It is certainly a question which demands settlement without further delay, and one which demands very earnest attention at the hands of those who are charged with its settlement. We recommend to congress a careful consideration of the condition of the American merchant marine, and of the position of the shipbuilders who are so situated as to be in direct competition with those of Europe.

ABSTRACTS FROM RULES AND REGULATIONS OF THE GREAT LAKES REGISTER.

EDITION OF 1904.

ARRANGED BY HARRISON S. TAFT.

PART I.

1. Measurements.

1. Length. L. From the forward side of the stem to the after side of the stern post, measured on a water-line calculated at 2 1-2 inches of freeboard for every foot molded depth of hold.

2. Breadth. B. Maximum molded beam.

3. Depth. D. From the upper side of the garboard strake to the top of the upper deck beams at center line amidships.

In awning-deck vessels the depth is to be measured to the under side of the deck next below said awning deck at center line amidships; but as stated in the preceding paragraph in determining the equipment number.

4. Scantlings Determined by Length and Depth.

Bar keels; stems; stern posts; flat plate keels; shell plating; frame spacing; rudder post and pintles; keelsons; keelson angles; bulkheads; ceilings; deck stringers; tie plates; deck plating; and stringer angle bars.

5. Scantlings Determined by the Formula: $B + D$.

Frames; reverse bars; floors; stanchions in connection with their length.

6. Scantlings Determined by Length of Vessel.

(*a*) The center vertical keelson, tank-top plating, side keelsons and keelson angle bars of double-bottom vessels.

(*b*) The side plating, deck stringers, tie plates, bulkhead plating and stringer angle bars of a poop, raised forecastle, quarter or awning deck.

7. Scantlings of beams is determined by the length of midship beams.

8. Equipment Number.

$$\frac{L \times B \times D}{125} + 80 \text{ per cent. of the capacity of all deck erections.}$$

2. Scarphs.

Scarphs of all bar keels, stems, and stern posts, should be in length not less than three and one-half times the depth of the bar keel.

3. Stems.

1. Stems are to be of the same scantling as the bar keels. They should maintain their full sectional area up to the load water-line, with a reduction to 3-4 of said area at their heads.

2. When worked with a flat plate keel the lower part should taper so as to be, at its extreme end, of the same thickness as the keel butt straps; and of the same width as the keel liners.

4. Stern Frames.

1. Stern frames in all vessels—except single-screw vessels—are to be of the same scantling as the bar keels. Those of single-screw vessels are to be of the same depth as the bar keels, but of increased width. There shall be a solid boss at the heel of the stern post to receive the foot pintle of the rudder.

2. Stern frames may be gradually reduced in sectional area above the counter, but said reduction must not exceed 1-4 of the full sectional area of the stern frame.

3. In sailing vessels and tow barges, that part of the stern frame forming the keel should extend forward of the vertical post at least 5 feet when the depth of hold is 12 feet and under; but 6 feet when said depth is above 12 feet. In single-screw vessels, it must extend forward at least 6 feet; with the foot knee extending at least four frame spaces when the tabulated depth of hold is over 12 feet.

4. That part of the shoe which is directly below the propeller is to at least equal the sectional area of the tabulated propeller post.

5. The sectional area on each side of the propeller boss shall be at least 65 per cent. of the tabulated section.

6. When worked with a flat plate keel the part extending forward of the vertical post should taper so as to be, at its extreme end, of the same thickness as the keel butt straps, and at least of the same width as the sum of the two keel angles plus the thickness of the vertical center keelson.

7. Gudgeons on the stern posts and rudders must not be spaced more than five feet apart.

5. Keels and Center Line Keelsons.

1. Center Vertical Plate Keels (single-bottom vessels).

(*a*) The depth of such keels is to at least equal the depth of midship floors plus the depth of the tabulated bar keel. Side plates, of the same depth as said bar keel, shall be worked on each side of the vertical plate keel below the floors; the thickness of said side plates being such as to render the combined thickness of the vertical plate keelson and the side plates the same as that of said bar keel. The side plates may be dispensed with if the vertical plate keel and garboard plates are all increased so that their combined thickness will be equal to that of the tabulated bar keel plus the garboard plates. The butts of the vertical keel and side plates must be well shifted from those of the garboard strakes.

(*b*) The top of said vertical plate keel must extend above the top of floors so as to be connected to a horizontal plate stringer of the same thickness as the garboards, worked on top of floors on each side of the vertical keel, by two continuous angle bars riveted back to back, embracing the upper edge of said vertical plate keel.

(*c*) 1. The vertical plate keel may extend above top of floors a sufficient height so as to allow of two top angles (and a rider plate if desired) besides the two above angle bars on top of floors; the above horizontal plate stringers being omitted. The four angles and that part of the vertical plate keel extending above the floors need not extend beyond the collision bulkheads; a flat horizontal plate being worked at center line in the fore-and-aft peaks, connecting the top of floors.

2. For 1-8 of the vessel's length at each end the angle bars may be reduced in scantling. In the machinery space the girder section is to be increased by 12 1-2 per cent. over the midship section of said girder.

2. Center Line Girder on Top of Floors (single-bottom vessels).

(*a*) Said girder is to have two top angles with a rider plate, and be secured to a horizontal plate stringer on top of floors by two continuous angle bars, riveted back to back, embracing said girder plate.

(*b*) Said girder is to extend from the forward to the aft collision bulkhead; intercostal plates with a top horizontal stringer plate being worked in the two peaks at the center line.

(*c*) The girder section may gradually be reduced by 12 per cent. for 1-8 length at each end, except in the machinery space, where it must be made 12 per cent. larger than the midship section.

3. Flat Plate Keels.

(*a*) They should maintain their midship scantling for 1-2 length amidships. No reduction from midship thickness will be allowed at the after end in screw steamers.

(*b*) They are to be connected to a continuous or intercostal vertical keelson by continuous or intercostal double angle bars respectively.

4. Intercostal Center Line Keelson (single-bottom vessels).

(*a*) When worked with a flat plate keel it should extend above top of floors according to requirements; with double angle bars or bulb angles on top of floors riveted back to back embracing the top edge of said keelson.

(*b*) A horizontal plate stringer may be worked on top of floors in connection with said bars, as stated in 5-1-*b*; each plate stringer being equal to the depth of midship floors.

6. Frames.

1. Frames are to maintain their midship scantling for 2-3 length amidships. Frames in the machinery space are to be of midship scantling. In the after end of steamers the frames must be of midship scantling. When the speed is 14 miles and above double angle bar stringers fitted with intercostal plates to the shell must be worked abaft the aft collision bulkhead.

2. All frames are to extend to the upper deck stringer plates. In way of an awning, a raised forecastle, poop or quarter deck, they are all to extend to the stringer plates of said decks.

3. With rounded gunwales the frames are to extend to the lower part of said gunwale; the beams being turned down at their ends and securely fastened to the top of the frames.

4. Intermediate frames, extending to the second deck in two-deck vessels and above the deep load water-line in single-deck vessels, are to be worked forward of the forward collision bulkhead.

5. The lower part of frames at extreme ends of ships should lap and be riveted to each other.

6. Frames at all collision bulkheads are to be worked double. Single frame bars may be fitted at all other watertight bulkheads, provided the standing flange is of sufficient size to permit of double riveting the same to the bulkhead plating.

7. Scarph pieces must be used at the center line butts of frames except when a continuous center line keelson is worked. They are to be of the same scantling as the frames and be long enough to take three rivets, spaced 6 inches apart, on each side of said butts.

7. Floor Plates.

double-bottom vessels.

1. A floor plate is to be fitted to every frame. They are to maintain their midship scantling for 2-3 length amidships, but no reduction will be allowed in the after end of screw vessels. Floors at extreme ends of ship must be increased in depth.

2. In sailing vessels and tow barges the weight of midship floors is to extend for 1-2 the vessel's length amidships, with a gradual reduction at the ends.

3. In steamers with machinery located aft, the floor plates from the forward collision bulkhead aft to the foremost floor of the engine and boiler space are to be of midship scantling.

4. All floors are to be secured to a center line vertical keelson with double clips of specified size for 2-3 length amidships including the machinery space. The double clips forward and aft of said 2-3 length are to be of the same scantling as the reverse bars.

5. All floors in the machinery space are to be 12 per cent.—those directly under the boiler beams 20 per cent.—heavier than midship floors; all of said floors being of the "solid plate manhole" type. When the boilers are located on the second or main deck, or on a specially built boiler deck, the above increase in weight of floors under the boilers may be dispensed with. Floors under said boiler deck must be strengthened in way of the quarter stanchions to said deck.

6. Bulkhead floor plates should be 10 per cent. heavier than other floors.

7. Floor plates of the collision bulkheads should be made deeper than other floors so as to permit the bulkhead plating being riveted to same above the tank top bounding angle bar.

8. A deep divisional floor should be worked under all hold bulkheads.

9. In single-bottom vessels the depth of floors must be 20 per cent. deeper than in double-bottom vessels.

10. Limber holes must be cut in all floors so as to provide a free flow for the bilge water to the pump. In double-bottom vessels the holes should be two inches in diameter.

11. Transom Floors. They are to be of the same weight as the midship floors but twice their depth at center line.

8. Reverse Bars.

1. A reverse bar must be fitted to every frame when the ordinary angle bar frame is used. They are to maintain their midship scantling for 2-3 length amidships, but no reduction will be allowed in the after end of screw steamers.

2. Double reverse bars are to be fitted on every floor in the way of the engine, but on alternate frames in the boiler space. Said doubling bars are to extend from bilge to bilge and be secured to the frames at the upper turn of the bilge. When the boilers are located on a special built boiler deck or on the main deck single reverse bars may be used in way of same.

3. When worked in connection with angle bar frames the reverse bars are to extend to the second and upper decks alternately. When the frame spacing is 24 inches, in way of a raised fore, a raised quarter, or poop deck, the combined length of which equals 1-2 the vessel's length, within said structures the reverse bars are to be fitted to alternate frames, and extend to said deck stringers.

4. In awning-deck vessels the reverse bars are to extend to the deck next below said awning deck on every frame and alternately to the awning deck in way of any erections upon said deck.

5. In spar-deck vessels the reverse bars are to extend to the upper and second decks alternately.

6. In way of a raised forecastle deck the reverse bars are to extend to said deck on alternate frames.

7. In sailing vessels, when the sum of their breadth and depth exceeds 60, the reverse bars are to extend to the upper deck on every frame.

8. In steamers, when the sum of the breadth and depth to the upper deck exceeds 35, the reverse bars in way of the machinery space and paddle boxes of side-wheel steamers are to extend to the upper deck on every frame. Web frames may be fitted in lieu of said reverse bars.

9. Bilge and Floor Keelsons. Side Stringers.

TABLE 1.—BILGE AND FLOOR KEELSONS.

Depth in Feet.	Bilge Keelsons.		Floor Keelsons.
	Upper.	Lower.	
14 under 18	D A	......	D A
18 " 26	D A	D A + I P $\frac{1}{2}$ L	D A
26 " 30	D A + I P $\frac{1}{2}$ L	D A + I P $\frac{1}{2}$ L	D B A + I P $\frac{1}{2}$ L
30 " 36	D A + I P T	D A + I P T	a. D B A + I P T

a. Two such keelsons to be fitted on each side.
Depth to be measured as per Section 1.
D A = double angles. D B A = double bulb angles.
I P $\frac{1}{2}$ L = intercostal plates for $\frac{1}{2}$ length amidships.
I P T = intercostal plates throughout.
Said bilge keelsons are to extend from peak to peak.
This table applies to single bottom vessels only

1. The clips connecting the intercostal plates to the floors and to the shell plating shall be of reverse bar size.

2. All intercostal plates and keelson angle bars are to be 10 per cent. heavier than otherwise in the boiler and engine space.

3. The floor and bilge keelsons should when possible terminate forward in a breast hook properly secured to the shell plating.

4. The breast hooks should not be more than 4 feet apart and should extend from the windlass deck to the peak floors. Similar breast hooks are to be worked aft.

5. There shall also be a panting stringer of the same section as the floor side keelsons, extending from the stem aft for 1-8 of the vessel's length, being secured to the reverse frames and reverse clips by four rivets at each frame. Where necessary said stringer should be chocked to the shell. Panting beams may also be fitted in the fore peak in connection with said stringer.

6. Side or Hold Stringers. See also Table 3.

(*a*), Plate side stringers are to be joggled around the frames and be connected to the shell plating by intercostal clips. They may be worked continuously or be cut at a web frame, but must be firmly secured to same. The butts are to be well shifted from the butts of the shell strakes in way of said stringers.

(*b*) Bracket plates are to be fitted at alternate frames so as to properly support the stringer plates.

(*c*) A continuous angle bar should be worked at the face of the reverse frames, and on the inboard edge of the stringer plates.

(*d*) When channel web frames are adopted channel stringers in connection with channel or "Z" bar intercostal chocks may be used. Said channel bar stringers should be connected to all web frames by double angle clips and a diamond plate.

(*e*) When the tabulated depth of a hold stringer exceeds the depth of a web frame, the depth of said web frame in way of same should be increased to that of the stringer with a diamond plate connection at the junction of the stringer and web; or else bracket plates must be fitted at the web frame both above and below the stringer. The stringer may be reduced to the depth of the web if the tabulated sectional area is maintained or additional stringers worked.

(*f*) When the distance between decks or stringers exceeds 8 feet additional strength must be provided.

10. Floor Clips.

Angle clips of reverse bar size are to be worked on all floors and frames in way of all angle bar and plate stringers.

11. Continuity of Stringers.

1. All hold and beam stringers, floor and bilge keelsons must be worked continuously through all bulkheads except the fore-and-aft collision bulkheads, to which they may be secured by bracket plates and angle clips.

2. Scarph or bosom pieces should be fitted at the butts of all continuous angle bar, bulb angle and channel stringers.

12. Web Frames.

TABLE 2.—WEB FRAMES.

Depth of Vessel in Feet.	Channel.		Plate.		Diamond Plates.	
	Ins.	Lbs.	Ins.	Lbs.	Ins.	Lbs.
14 to 16	12 ×	20	12 ×	12½	18 × 18 ×	15
17 " 19	12 ×	25	13 ×	12½	19 × 19 ×	15
20 " 22	12 ×	30	14 ×	15	21 × 21 ×	17
23	12 ×	30	15 ×	16	22 × 22 ×	18
24 to 26	15 ×	33	15 ×	16	22 × 22 ×	18
27	15 ×	33	16 ×	17½	24 × 24 ×	20
28	15 ×	35	16 ×	17½	24 × 24 ×	20
29	15 ×	35	17 ×	17½	25 × 25 ×	20
30	15 ×	40	17 ×	17½	25 × 25 ×	20
31 and 32	15 ×	40	18 ×	18½	27 × 27 ×	21
33 " 34	17 ×	45	19 ×	18½	28 × 28 ×	21
35 " 36	20 ×	50	20 ×	20	30 × 30 ×	22½

Depth measured from top of floors to upper deck at center line amidships.

1. A web frame must be fitted at each side of a cargo gangway when same is located on the second deck.
2. When the deck height exceeds 8 feet, extra compensation in the way of web frames will be required.
3. Web frames are to be fitted in the machinery space in lieu of lower deck or hold beams.
4. Web frames of surpressed decks are to extend from the floors or tank top to the upper deck (not awning deck) and be connected to the margin plate and upper deck beams by efficient bracket plates.
5. For Spacing of Web Frames See Table 3.

13. Deck and Hold Beams.

1. Deck and hold beams should be located vertically over each other. Those of the upper deck, raised forecastle, poop, awning and quarter decks, and the short beams in way of deck openings, must be fitted to alternate frames.

2. The fore-and-afters at all deck openings should be of the same scantling as the end beams to which they are attached.

3. The short beams at wide hatches may be reduced by 10 per cent. from the tabulated size.

4. Box beams, when used, should be one frame space wide; being built of two beams on adjacent frames

TABLE 3.—ARRANGEMENT OF DECK BEAMS; WEB FRAMES; AND HOLD STRINGERS.

Type.	Hold Beams and Hold Stringers.			Web Frames in Lieu of Hold Beams.				Hold Beams and Web Frames when no Lower Decks are Laid.			
	Depth in Feet.	Spacing of Hold Beams.	Type of Hold Stringer.	Depth in Feet.	Spacing of Web Frames.	Spacing of Hold Beams.	Type of Hold Stringer.	Depth in Feet.	Spacing of Web Frames.	Spacing of Hold Beams.	Type of Hold Stringer.
One deck vessels.	14	12 Fr.	....	14	12 Fr.	....	Plate.	14	12 Fr.	....	Plate.
	15 and 16	8 "	....	15 and 16	8 "	....	"	15 and 16	8 "	....	"
	17 " 18	6 "	D A	17 " 18	8 "	....	a. "	17 " 18	8 "	....	a. "
	19 " 20	4 "	Plate	19 " 20	6 "	....	a. "	19 " 20	6 "	....	a. "
	21	Alt. "	"	....	....	....	....	21 to 23	6 "	6 Fr.	"
	....	....	....	....	....	.	....	24	4 "	4 "	"
	....	...	....	....	....	....	....	25 to 30	4 "	4 "	a. "
Two-deck vessels.	22 to 24	12 Fr.	....	21	— Fr.	....	Plate.	31 and 32	4 Fr.	....	a. Plate
	25 and 26	8 "	Plate	22 to 24	12 "	....	"	34 to 36	4 "	12 Fr	"
	27 " 28	6 "	"	25 and 26	8 "	....	a. "	....	....	....	...
	29	4 "	"	27 to 29	6 "	....	a. "	....	....	....	...
	30 to 32	Alt. "	"	30	4 "		a. "	....	....		....
	....	....	....	31 and 32	4 "	12 Fr.	"	....	....	....	....
	....	....	....	34 to 36	4 "	8 "	"	....	....	....	...
A	34 to 36	12 Fr.	....	....	....	....	....	....	....	....	....

A = three deck vessels. a. Two hold stringers.
Upper deck beams to be located on alternate frames.
Depth to be taken from top of floors to upper deck at center line amidships.

connected together by a plate on top, and by stays on the underside. Said box beams should have gusset plates at their ends, extending three beam spaces before and abaft of said beam and three feet on the beam itself, being double riveted on both sides.

5. When proper quarter stanchions are fitted, deck beams so supported can be 10 per cent. lighter than otherwise.

6. The vertical spacing of deck beams below the upper deck, in two-, three-, and spar-deck vessels, is to be regulated by the depth from top of floors to the upper deck amidships. In awning-deck vessels the depth is to be taken to the deck next below the awning deck. In double-bottom vessels the depth is to be taken at center line amidships to the under side of said decks.

14. Beam Knees and Brackets.

1. When the knees are of plate, their thickness is to be the same as the web of the beam to which they are attached. Their diagonal edge should be flanged.

2. Plate knees to the upper deck beams are to be on each side three times the depth of said beam, and twice said beam depth across their throat. All other plate knees are to be respectively 2 1-2 and 1 3-4 times the depth of the beam to which they are attached.

3. Welded knees at beam ends should be in depth 2 1-2 times the depth of the beam.

4. (*a*) When fitted to channel beams (in connection with web frames) the knees are to be secured to the lower flange of said beams by an angle clip or by a flanged edge on the bracket plate. These knees are to be in depth twice the depth of the beam they are attached to.

(*b*) When the length of a beam exceeds 44 feet (beams and stanchions being of channel), and no quarter stanchions are worked, similar bracket plates must be fitted to the center line stanchions at both upper and lower decks. When no decking is fitted on the main or lower deck beams, knee brackets should be fitted to both top and bottom of said lower deck beams, securing same to the stanchions.

15. Stanchions.

1. When the beams are spaced more than one frame space apart stanchions should be fitted to every beam. When the beams are spaced on every frame the stanchions should be located under alternate beams, being secured to a continuous fore-and-aft girder under said beams.

2. (*a*) When the tabulated length of a beam is 48 feet or over a row of quarter-stanchions should be worked under the main-deck beams midway between the center line and the side of the ship. Said stanchions are to be in sectional area 2-3 that of the center stanchions and be spaced 8 feet apart.

(*b*) If the quarter stanchions are of the same size and spacing as the center stanchions, said center stanchions may be omitted.

(*c*) In lieu of quarter-stanchions wing stays may be adopted. Said stays being fitted at web frames, extending from the channel tie at hatches to the hold stringer, for 2-3 the vessel's length amidships.

3. When the length of the stanchions exceeds 8 feet they should be connected together by some kind of a tie plate at their half length.

4. Suitable stanchions should be worked under a raised boiler deck, a windlass deck, and all deck winches or other heavy deck weights.

16. Deck Plating, Stringers, and Tie Plates.

1. Deck Plating.

(*a*) In no case is the deck plating at ends to be of less than 10 pounds. Deck plating between hatches should be worked in one length. When a steel deck does not exceed 10 pounds, with beams fitted to alternate frames, and no wooden deck is laid thereupon, stiffening angles shall be worked under each strake of deck plating; the ends of said angles being secured to the deck beams.

(*b*) When the length athwartship of an upper-deck hatch does not exceed 1-3 the vessel's beam, the deck plating between the upper-deck stringers is to be 20 per cent. heavier than otherwise for the 1-2 length amidships.

(*c*) Boiler-deck plating is to be of not less than 17 1-2 pounds. There shall be a plate or flange 12 inches in height at inside of the frames; said deck being made watertight thereat by cement or otherwise.

(*d*) A plate of suitable size to take all holding-down bolts is to be fitted on the under side of the deck beams in way of all windlasses, capstans, and steering engines; also for quarter-blocks and guide sheaves.

(*e*) All steel decks are to be caulked and made watertight, being fitted with suitable drain pipes.

2. Deck Stringers.

(*a*) Said stringers are to maintain their full midship scantling for 1-2 the vessel's length amidships, except in those vessels with their machinery located aft, in which case the full midship weight is to extend forward from after end of the machinery space for 2-3 of the vessel's length.

(*b*) When the athwartship length of an upper-deck hatch is over 1-3 the vessel's beam the stringer plates of said deck are to be heavier than otherwise.

TABLE 4.—WIDTH OF DECK STRINGERS.

Deck.	Athwartship Length of Upper Deck Hatches.	Stringer Width.
Upper deck stringer..	Over $\frac{1}{3}$ vessel's beam........................	$\frac{1}{6}$ of vessel's midship beam.
" " " ..	Not over $\frac{1}{3}$ vessel's beam.....................	$\frac{1}{10}$ " " " "
Second " " ..	....	$\frac{1}{12}$ " " " "
Third " " ..	....	$\frac{1}{24}$ " " " "

(c) The butts of the upper-deck stringers should be shifted at least two frame spaces from the sheer-strake butts.

(d) Stringers are to be worked continuously through all bulkheads except the fore-and-after collision bulkheads, to which they may be bracketed. The bracket plates are to equal the lower plating of collision bulkheads and have a double angle-bar connection to said bulkheads.

(e) The ends of the stringers in the end peaks should be strongly fastened together by a breast hook.

(f) In steel barges the upper-deck stringers may be 10 per cent. less in weight than specified for steamers.

3. Tie Plates.

(a) Tie plates must be fitted on top of the deck beams at ends of all hatches when a wooden deck is laid so as to support the ends of the deck planking. They should also be fitted to the second deck and hold beams when no decking is laid thereupon, being of angle or channel section.

(b) All tie plates or angle bars in way of hatch ends are to extend continuously from peak to peak. In the machinery space they can be worked to suit conditions therein.

(c) When the length of a vessel is 350 feet or above, especially single-deck bulk freight vessels with large transverse hatches, a fore-and-aft tie of suitable form should be worked continuously in the way of hatch ends on the under side of the upper-deck beams, with intercostal plates or chocks between the beams, so as to stiffen the deck plating.

(d) Vessels of 45-foot beam and above, with a wooden deck and small hatches, should have an additional tie plate between the stringer plates and the tie plates at sides of the hatches, with diagonal tie plates between the same.

(e) In vessels with large, transverse hatches, tie plates must be worked so as to connect together all the main-deck beams between the hatches. Also the beams of the second and third deck where no decking is laid thereupon.

(f) At sides of hatches the tie plates are to be double their ordinary width with a gradual taper beyond the hatch to their regular width.

4. Mast Partners.

(a) When no steel deck is laid the mast-partner plates are to be of the same thickness as the deck tie plates. They are to be four frame spaces in length, and in breadth twice the diameter of the mast hole.

(b) When a steel deck is laid a suitable doubling plate should be worked at each mast partner. Said plates to cover three beam spaces in a fore-and-aft direction and be in width three times the diameter of the mast hole.

(c) A coaming ring of the same size as the keelson bars is to be worked around the mast hole on the upper side of the plating.

17. Bulkheads.

1. A watertight bulkhead shall be located aft of the stem (measured on the load water-line) at a distance equal to one-half of the vessel's beam. There shall also be a watertight bulkhead a sufficient distance forward of the stern post with a doubling plate, of the same weight as the bulkhead plating, at the hole for the stern tube. A watertight bulkhead shall be worked at each end of the machinery space.

2. All watertight bulkheads should extend to the upper deck.

3. All watertight bulkheads are to have double frame angles, or single frame angles double riveted in both flanges, and be connected to the inner-bottom plating by double angles of reverse-bar size.

4. Vertical stiffeners are to be located on the after side of all bulkheads, spaced 30 inches apart; with the horizontal stiffeners worked on the opposite side spaced not over 4 feet apart. Horizontal stiffeners need not be worked above the second deck except on the collision bulkhead.

5. Forward Collision and Other Watertight Bulkheads.

(a) When said bulkheads are over 38 feet wide at their widest part a web plate with double-face angles extending from top of floors to the lowest tier of beams, is to be fitted to the center vertical stiffener.

(b) When said bulkheads are 40 feet in width, the horizontal stiffeners are to be of increased size.

(c) When the width of the widest part is 45 feet and above, a web plate is to be located on each side of the center web plate midway between it and the ship's side. Said side webs are to be similar to the center web.

6. When the height of a watertight bulkhead is 13 feet or over to the second deck (to upper deck in single-deck vessels), bracket plates are to be fitted to both the upper and lower ends of its vertical stiffeners, connecting same to the tank top and deck plating. With a wooden deck a transverse plate should be fitted on the deck beams for securing said brackets to the deck.

7. No opening will be allowed in the collision bulkheads, access to the fore-and-aft peaks being by hatchways and ladders through the decks above same.

8. A watertight door may be worked in the engine-room bulkhead; same to work from the upper deck.

9. Bulkhead liners are to extend from one frame space on each side of the bulkhead frame.

10. The ends of horizontal stiffeners should be connected by bracket plates to the side stringers, being worked in way of same.

11. The fore-and-aft peak bulkheads are to be tested by filling said peaks to the deep load water-line.

12. Coal-Bunker Bulkheads.

(a) The plating is to be of the same weight as that of the cargo-hold bulkheads. When of 12 feet or more in depth the horizontal and vertical stiffeners are to be of the same scantling as the reverse bars; when of less than 12 feet in depth the stiffeners may be of a trifle less scantling. The stiffeners are to be spaced as on the cargo-hold bulkheads.

(b) When not worked in way of a beam, transverse bulkheads are to be secured to the deck plating by double angle bars. All coal-bunker bulkheads are to have a double angle-bar connection to the tank-top plating.

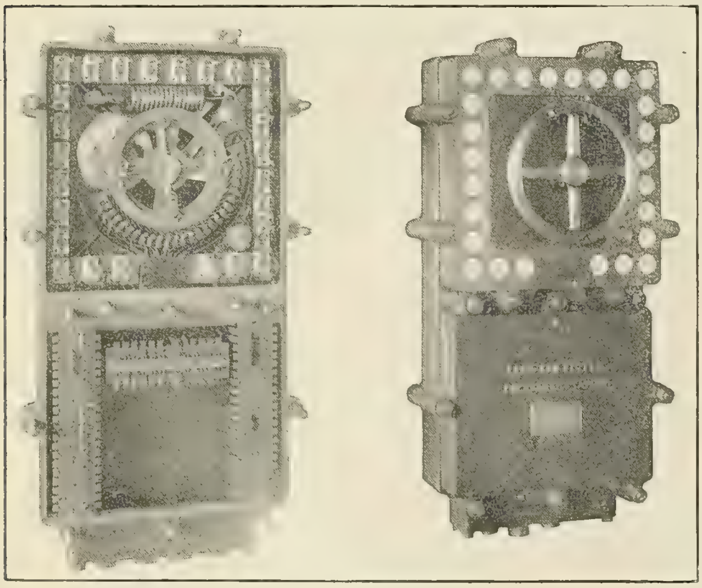
(*To be continued.*)

ENGINEERING SPECIALTIES.

An Ingenious Piece of Electrical Mechanism.

On all the new warships of the navy there is installed what is known as the "Long-Arm" system of electrically-operated bulkhead doors and hatches. The heart of the system is the central emergency station from which the doors and hatch plates may be closed by starting the motors with which they are equipped. The working parts of the station are contained in a two-part watertight case secured to the side wall of the pilot house or other convenient place above decks. The apparatus of the station consists of three parts: the mechanism for controlling the circuits running to each door or hatch gear for closing the same; the lamps which indicate the closure of each door or hatch; and the fuse box in which each entering wire is supplied with its proper fuse. The accompanying photograph shows the emergency station as closed, and with the protective covering removed.

To operate the emergency station the officer in charge releases a hand wheel, which, in turn, releases a gear driven by a powerful spring and controlled by a suitable escapement. This gearing closes the circuits for operating the emergency switches located in the controller of each door and hatch gear. In performing this



function the gearing does not start all the motors at the same instant, for the reason that this would demand a large supply of current from the ship's generators. It starts them one after the other at about a three-second interval, so that it rarely happens that more than four motors are in operation at any one time, although the entire closure of twenty-four doors and hatch gears controlled from one emergency station may be accomplished normally in about a minute and a quarter. When, however, an extremely quick closing of all doors is required, this time can be reduced to thirty seconds for twenty-four doors by simply using the hand on the wheel of the emergency station to hurry it; and this action does not alter the closing speed of any individual door or hatch.

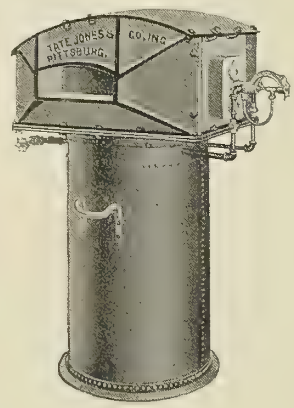
As each bulkhead door reaches its watertight seat, it automatically closes a circuit running to the emergency station, there connected with one of the small incandescent lamps. Transparent discs over these lamps bear numbers corresponding to the numbers of the various doors under control. The officer in charge, by pressing a button, can cause the indicator lamp of every closed door and hatch to glow, thereby assuring himself of the successful operation of the emergency action. If any door is prevented from closing by obstructions left in its path, this fact at once is apparent to the officer in charge, and no time need be lost in reaching the scene of the difficulty.

The emergency station contains but one spring, which furnishes the entire power for operating the device. This spring is of the helical type, and of ample strength for the work it is called upon to do.

Although the experience of hard sea-service has shown that the emergency station of the Long-Arm system can be depended upon for successful operation at all times, the mechanism can, if necessary, be actuated at any time by turning the hand wheel located in front of the case, should the station fail to act automatically by the power of the spring when released. During any emergency period a red indicator lamp glows continuously, so that a casual glance at the emergency station shows at once whether the emergency is "on" or "off." After a danger period is passed, and it is desired to again establish normal conditions below, the emergency may be thrown off by a hand reversal of the same operating device which is used to throw it on, so that the mechanism when not in use is always set ready to operate, and always available in time of need.

Oil Rivet Forges.

The illustration shows a forge designed for heating rivets, and used also for quite a variety of other work. The fuel is oil, which may be of almost any character, and which may be contained in the forge tank in sufficient quantity to last for two days. A blast is furnished by compressed air, which forces the oil to the burner and furnishes the air for atomizing the fuel. The pressure of this blast is reduced by a valve to twenty pounds. Both the air and the oil in the burner are controlled by one lever with fixed adjustment. The advantages claimed for this forge are: the small

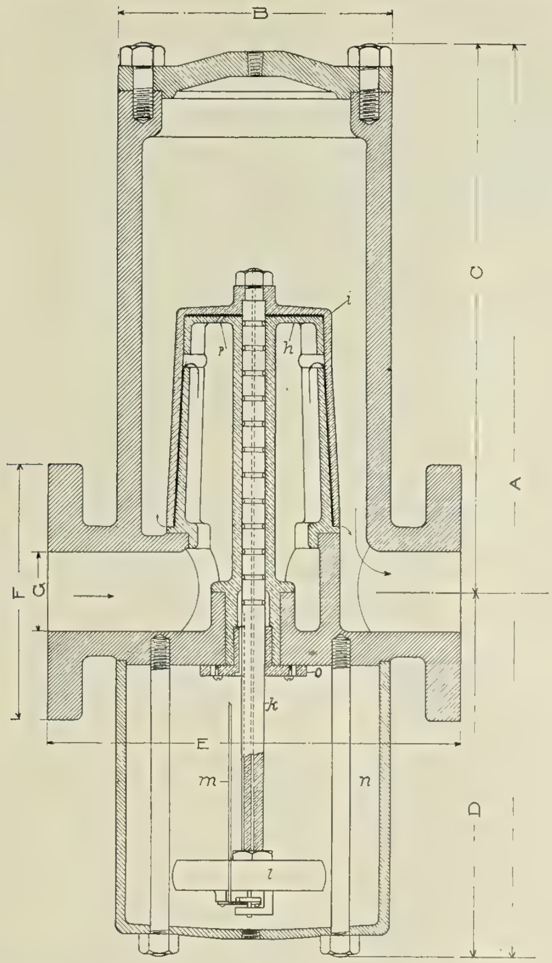


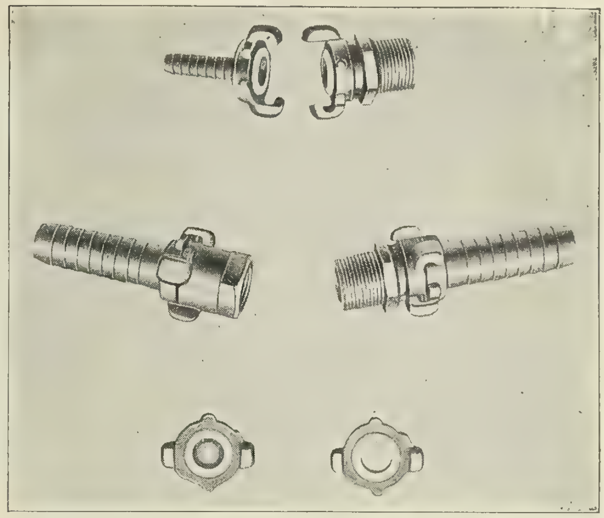
quantity of compressed air required; automatic regulation; a single valve for control; the perfect atomizing of the oil; and the limiting of the heating given the rivets to that required for riveting.

The machine, as placed on the market by Tate, Jones & Company, of Pittsburg, is built in two sizes, with capacities respectively of 800 and 400 ½-inch rivets per hour. The larger size weighs 750 pounds and consumes 1½ gallons of oil per hour; while the smaller size, of 400 pounds, consumes 1 gallon per hour.

The Sargent Steam, Gas, and Compressed-Air Meter.

This instrument is the outcome of a demand for a practical device which will measure or indicate the weight of steam flowing through a pipe. In the improved form, the meter is connected up in the steam pipe or by-pass, which allows all the steam that is to be measured to pass through, and this amount is indicated by the position of the needle on the dial. Meters are made so that the steam may flow in either direction, as desired. The sectional elevation of the meter shows the passage of the steam and the moving parts. Steam, entering from the left and rising around the valve-stem guide, passes through the small hole *p*, and raises the valve *i*. This allows the steam to pass down between the two cones and the valve seat to the discharge side. As the valve stem

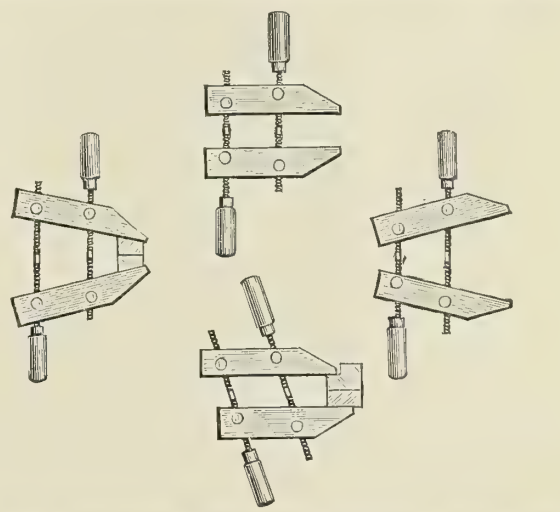




thread, and hose in standard commercial sizes, from one-quarter inch up to one inch, which enables all couplings to be made without resorting to reducers or special shanks, to meet the conditions presenting themselves where pneumatic tools are in use. The couplers are manufactured by the Chicago Pneumatic Tool Company, their facilities being equal to 500 sets per day.

The Jorgensen Clamp.

For the use of pattern makers, wood makers, machinists, and boat builders, the clamp of which we present illustrations is said to have considerable advantages over the old-style hand screw. The spindles are cold-rolled steel with right and left hand threads,



so that both jaws operate together and produce double the speed of the old arrangement, while it is possible to adjust a single clamp in any of the positions illustrated or any modifications of them. Adjustment is produced by the spindles passing through steel sockets in the jaws. These sockets revolve when necessary, and remove all friction between spindle and jaw. The makers are the Adjustable Clamp Company, 1031 Unity Building, Chicago, Ill.

k is open to the atmosphere at the bottom, the pressure on the discharge side of the meter tends to close the valve and force it to its seat. Due to the area of the valve stem, there will be a difference of 2 percent in the pressure between the outlet and inlet sides. As the pressure increases, more steam will go through a constant opening; or, as the weight remains constant, the opening will be less. In order to compensate for variations in pressure, a Bourdon spring is connected to the bottom of the valve stem, and moves the needle transversely as the pressure varies. With a constant weight of steam flowing through, the valve would be open twice as wide for 50 pounds pressure as for 100 pounds, from which we see that the horsepower lines go down as the pressure goes up. The meter is calibrated by weighing the condensed steam flowing through under different pressures and valve openings, and the trial dial thus obtained is transferred to the permanent metal dial. As the meter has but one moving part, it is not liable to get out of order. It is manufactured in sizes from 1 to 6 inches by the Sargent Steam Meter Company, 1320 First National Bank Building, Chicago.

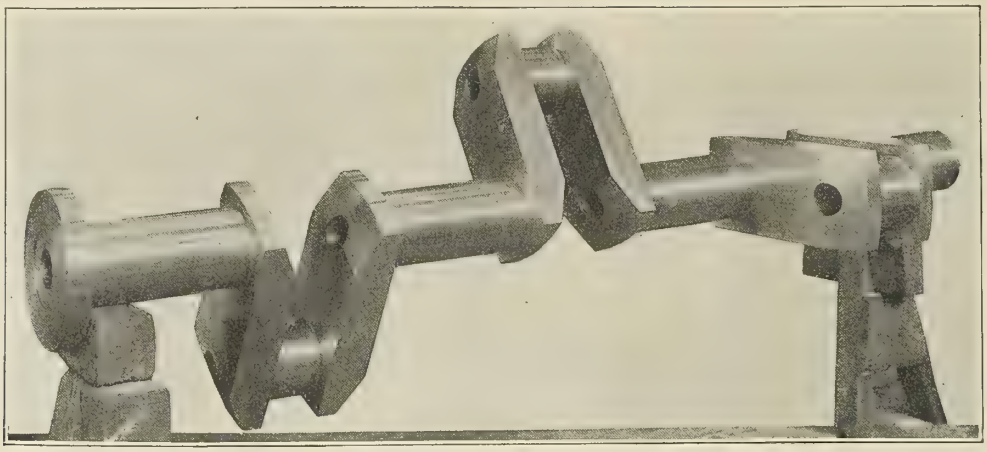
The Chicago Hose Coupler.

This device was designed to meet the demand for a universal coupler whereby a plant once standardized could be thereafter economically maintained standard without extra expense for specially-constructed couplers to suit various sizes of hose used with pneumatic tools. By reference to the illustration it will be observed the Chicago coupler has no male or female part at coupling end proper, but instead each half has embodied therein both male and female features whereby each and every half is exactly the same, and will couple regardless of the size and style of the shank, rendering the same a universal coupler in every sense of the word. It will readily be seen that quarter-inch hose may be coupled to three-quarter-inch hose, one-inch pipe, or anything having one of these couplers attached to it.

The shanks are manufactured for pipe male thread, pipe female

Marine Forgings.

The illustration shows a forged steel marine triple-cylinder crankshaft, which was manufactured by the Sizer Forge Company, of Buffalo, N. Y., for the United States government. This style of crankshaft is probably the most difficult to manufacture of any of the marine cranks. The hollow boring of the shaft throughout demands that the ingot from which the forging is made be absolutely sound throughout, for if even a small hole were in the center of the ingot, and, therefore, in the forging, as the hammers cannot completely weld up these pipes, the drill which is used in hollow boring would follow such a hole, or pipe, and throw the boring out of center. While the hammers cannot



weld up holes in the ingots, they can greatly increase the density and strength of the steel. All steel castings are to a certain extent porous, especially toward the top of the ingot. Their porousness can be completely overcome if an ingot or billet enough larger than the forging is used to insure the proper working of the material. Another very essential point in obtaining satisfactory results in forgings, especially in the manufacture of crank shafts, is the using of a hammer which is sufficiently large and heavy, so that at each blow the center, and not only the outside of the ingot, or billet, is manipulated.

Another point that might bear mentioning here is the question of reducing, as far as possible, the strains which are caused by the hammer when forging. As the steel begins to cool the minute it leaves the furnace to go under the hammer, you might say that no two blows of the hammer are struck under equal strain conditions. The only way to overcome this difficulty is to do less hammering per heat than is the common practice, and then after the forging is ready for the machine shop to heat the job in its entirety to a uniform heat, and cool it equally in all parts. Large crankshafts, which have not been forged and treated under these conditions, are often out of line at the throw as much as ⅜ inch after the material between the throws has been slotted out preparatory to turning the pin; while similar cranks made under the process used by the Sizer Forge Company show about $\frac{1}{32}$ inch variation and sometimes none at all.

TECHNICAL PUBLICATIONS.

The Application of Graphic and Other Methods to the Design of Structures. By William W. F. Pullen. Second edition. Pages 341; figures 158. Manchester: The Technical Publishing Company, Ltd., 1905. Price five shillings net.

The first edition of this work was issued in 1896, and the second edition is very similar to the first, with the exception of the chapter on Struts, which has been rewritten and placed in more systematic form than was the case in the first edition. The work is one of a great deal of importance, particularly to engineers concerned with the design of bridges, cranes, roofs, and other structures on which the loads to be met are known with a greater or less degree of accuracy; and the methods of treatment coupled with a copious use of diagrams ought to render it very valuable.

Transmission of Heat Through Cold Storage Insulation. By Charles P. Paulding, M.E. Pp. 41 + 32; figures 7. New York: D. Van Nostrand Company, 1905. Price $1.00 net.

Based upon the experiments of the French physicist Péclet, and the laws deduced from them in his famous treatise on heat, the text of this little book has been designed as a working manual for engineers concerned with the construction of refrigerating rooms and cold-storage warehouses. Tables are given showing the relative heat conductivity of the various materials entering into the construction of such plants, and concrete examples for illustrating the use of the tables and giving an idea as to the method of obtaining results.

QUERIES AND ANSWERS.

All reasonable questions concerning marine engineering received from and signed by subscribers will be answered by the Editor in this column. All communications must bear the name and address of the writer.

Q. 305.—Will you kindly answer the following questions:

(1) How can I find mathematically the compression pressure (in pounds per square inch) in a gasoline engine whose cylinder is 6 inches diameter, 6 inches stroke, making 500 R.P.M., depth of compression space being 1½ inches?

(2) What will be the force of the explosion in pounds per square inch on the piston? M. F. G.

A.—(1) Without information regarding the time of closure of the exhaust valve of the engine you mention, it would be out of the question to find mathematically the compression pressure in pounds per square inch. It might be said off-hand, however, that with dimensions given an engine of the ordinary design ought to give an ultimate compression of nearly 100 pounds per square inch.

(2) The force of the explosion in pounds per square inch would depend largely upon the quality of the mixture of gas admitted to the cylinder, and would be found to be somewhere in the neighborhood of 300 to 325 pounds per square inch.

Q. 306.—Please explain the meaning of cylindrical coefficient, block coefficient, and midship-area coefficient, and oblige, Ingannus.

A.—If a rectangular mass of water with length, breadth, and depth equal respectively to the length, breadth, and draft of a ship be taken, and the volume of the submerged part of the ship compared with the volume of this water, the result will be the block coefficient of the ship. In other words, the block coefficient of a ship is equal to the ratio between the displacement of the ship itself and the volume of the circumscribing rectangular form.

The midship area coefficient is the ratio between the area of the immersed midship section of the ship and the area of a rectangle whose two dimensions are respectively the width of the ship and the draft amidships.

The cylindrical coefficient, which is frequently called the prismatic coefficient, is the relation between the actual volume of water displaced by the ship and the volume of a mass of water whose length is equal to that of the ship, and whose cross section, which is uniform in size and shape, is the same as the actual midship section of the ship.

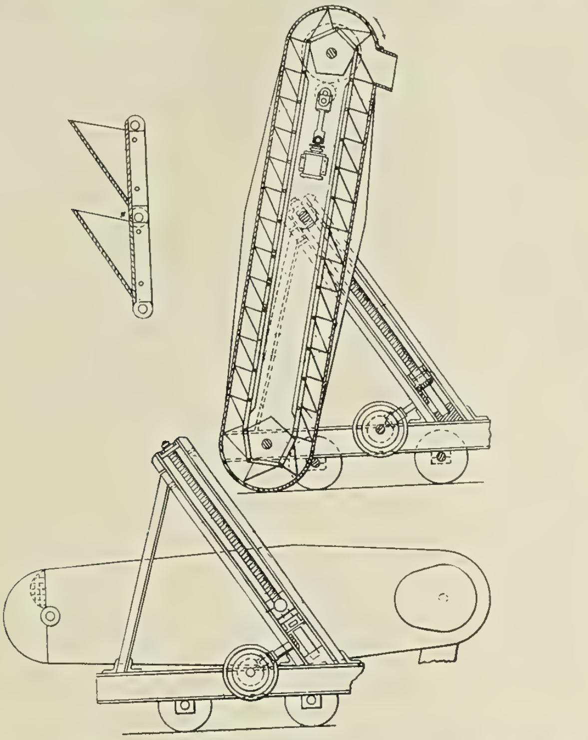
The block coefficient shows the general result of "fining" the ship both at the ends and around the bilges, while the cylindrical or prismatic coefficient shows the effect of fining simply at the ends, and is independent of the shape of the bilge, being figured from that as a basis.

We are informed that the Mississippi River dredge *Barnard*, which was described at length in our October number, was originally designed by Mr. Thomas Middleton, engineer of the Mississippi River Commission, who drew up the specifications under which she was built by the New York Shipbuilding Company.

SELECTED MARINE PATENTS.

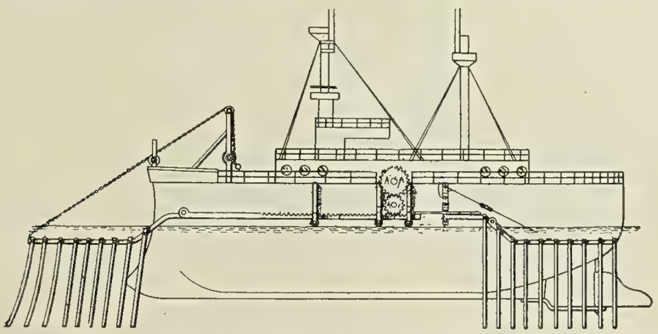
797,116. ELEVATOR FOR LOADING AND UNLOADING COAL, ETC. GERALD E. HOLLAND AND HENRY JOHNSTON, RANGOON, BURMA, INDIA, ASSIGNORS TO THE HOLLAND JOHNSTON PATENTS, LIMITED, OF LONDON, ENGLAND.

Claim.—3. An elevator comprising an endless chain of buckets, a casing forming a continuous trunk for said chain of buckets and having an open-

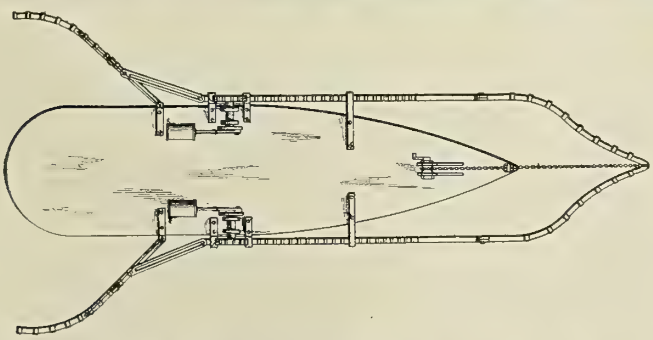


ing at each end thereof, a driving motor mounted between the limbs of said trunk, a suspension shaft secured to the casing above the center of gravity of the elevator, a frame having movable bearings for said shaft, and means for raising and lowering said bearings to tilt the elevator. Five claims.

797,235. WARSHIP. JOHN SLONKA, YONKERS, N. Y., ASSIGNOR OF ONE-HALF TO JOSEPH KAMP, YONKERS, N. Y.



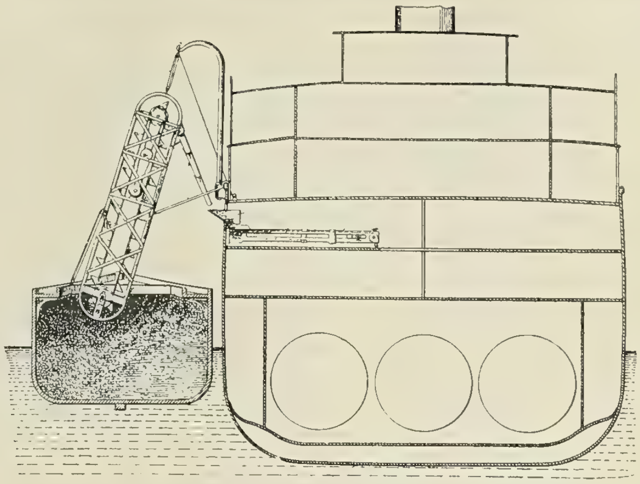
Claim.—1. A guard for vessels, comprising a front forwardly-projectable fender having rearwardly-extending bars provided with racks, rear pivoted



laterally-projectable fenders connected with and operated by said bars and pinions engaging the racks of said bars and reciprocating them. Four claims.

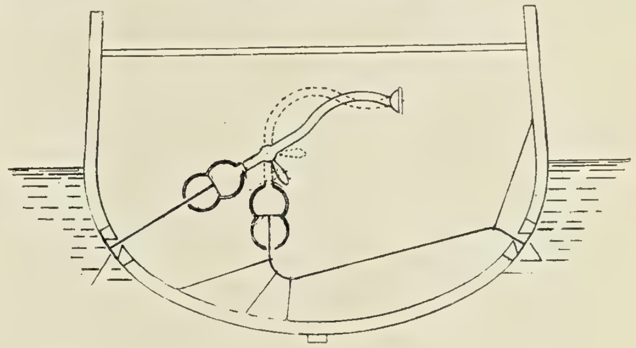
797,364. APPARATUS FOR COALING VESSELS. LOUIS A. DE MAYO, NEW YORK, N. Y.

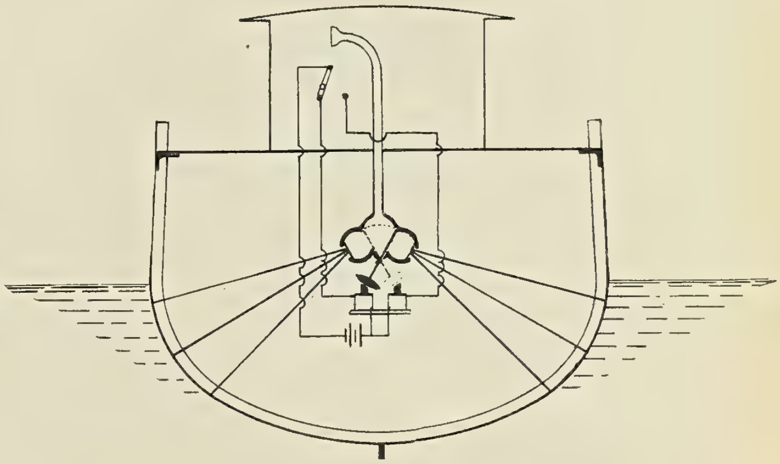
Claim.—1. In an apparatus for coaling ships, the combination of an elevator, means for mounting the same outside of the ship, a discharge chute leading from the elevator to the coal port of the ship, a distributer located within the ship and receiving the coal from the elevator discharge chute, and mechanism for driving the elevator and distributer; the said distributer comprising an apron and extensible frame sections. Thirteen claims.



798,202. SOUND-RECEIVING MEANS FOR SUBMARINE SIGNALING. JOSIAH B. MILLET, BOSTON, EDWARD C. WOOD, SOMERVILLE, AND HORACE B. GALE, NATICK, MASS., ASSIGNORS TO SUBMARINE SIGNAL COMPANY, OF WATERVILLE, ME., BOSTON, MASS., A CORPORATION OF MAINE.

Abstract.—The invention comprises primarily a wave-receiving diaphragm, so mounted in the ship or receiving station as to receive the incoming sound waves and to be vibrated thereby, preferably in contact with the water, although not necessarily with the open-sea water.

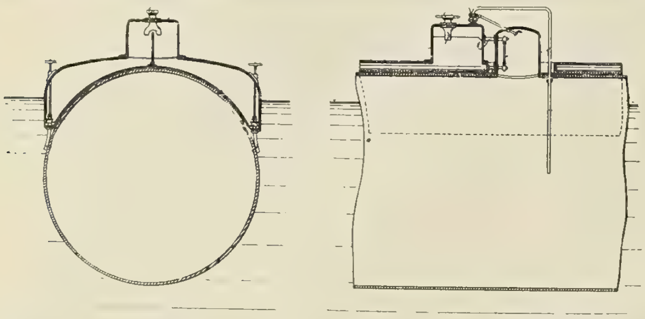




The invention comprises also receiving means which in some instances may act as resonating or intensifying means. Such means may be located at any convenient point, which may be in the immediate neighborhood of the receiving diaphragm on or near the side of the ship, or may be at a distance therefrom and at a point in the interior of the structure. As an element of the receiving means is another diaphragm, which for convenience we may call a "secondary" diaphragm. This secondary diaphragm is not necessarily of the size of the primary receiving diaphragm, but preferably and usually much smaller. The two diaphragms are connected, preferably, from their central points by a good sound conductor, the material of which is not important, but which depends to some extent upon circumstances—such, for instance, as the relative positions of the connected diaphragms. The conductor is relatively long and thin and extends tautly or comparatively rigidly between the two diaphragms. This vibratory connection, which may be a wire, rod, or cord, or the like, is very sensitive to vibrations the direction of which is along its axis, but is not sensitive to cross vibrations. It will therefore receive from the primary diaphragm, against which the sound waves impinge, only vibrations in the direction of its length and will deliver to and effectively operate the diaphragm of the receiving means through such vibrations only. In other words, the conductor will not receive and deliver to the last named or so-called "secondary" diaphragm any of the vibrations ordinarily created by local disturbing agencies. By locating the receiving means at a point well within the ship or other structure and by making the sound conductor between the diaphragms relatively long several of the primary receiving surfaces may be connected to a single secondary receiving diaphragm or to a set of said diaphragms conveniently located, whereupon by means of a switching or selecting mechanism any receiving surface can be readily connected to the operator to enable him to determine by relative intensity of action from which direction the sound emanates. Twenty-three claims.

798,501. SUBMARINE BOAT. RAYMOND D'EQUEVILLEY, KIEL, GERMANY.

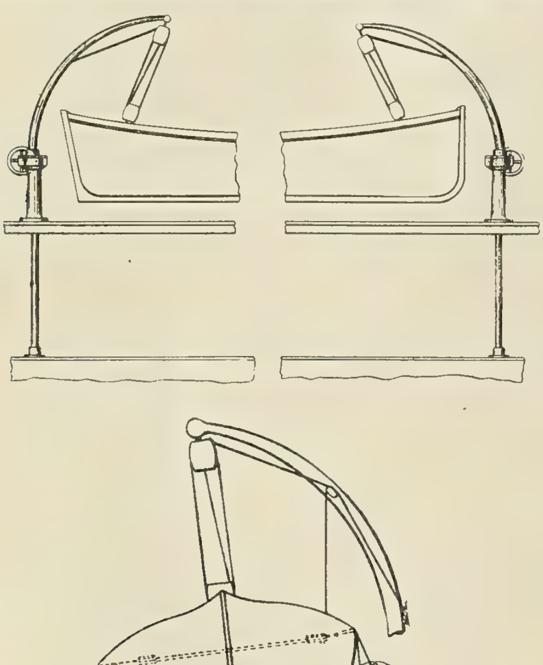
Claim.—4. In a submarine boat, a fuel reservoir arranged on the exterior of the boat, means providing communication between the interior of



the boat and the upper portion of the reservoir, and means providing communication between the exterior water and the lower part of the reservoir. Five claims.

798,973. HOISTING AND LOWERING MECHANISM FOR BOATS. FRANK S. PETT, DOVER, ENGLAND.

Claim.—5. In a boat hoisting and lowering mechanism, the combination of mechanism for supporting the boat, a hinged drop-down spar adapted to

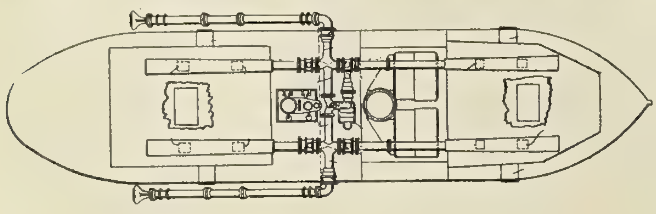


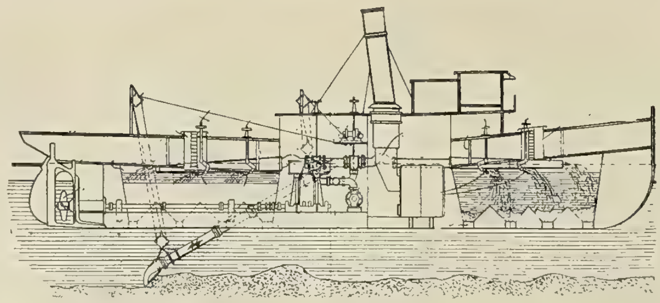
move inboard below the path of the boat supported by said mechanism as said boat is swung over the ship's side onto the deck thereof, and means for securing the spar in a normal closed position. Seventeen claims.

799,256. SUCTION DREDGE. LEVIN S. PARKER, NEW YORK.

Abstract.—The invention comprises specially-arranged bins for the dredged material and specially constructed and arranged pumping machinery and suction and discharge pipes leading to said bins, which preferably will be located forward and aft of the machinery space of the dredge.

One object of the invention is to provide highly-efficient pumping and suction apparatus or machinery in the use of which the dredged material will not pass into contact with the pump mechanism, but will be induced to



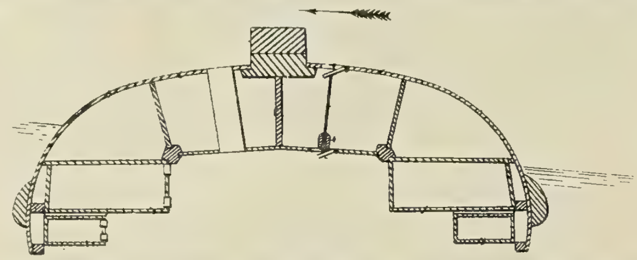


flow through the connected suction and discharge pipes by means of an auxiliary stream of water delivered by the pump into the said discharge pipe, said pump taking its supply of water through a separate pipe leading through the side or bottom of the dredge.

A further object of the invention is to so construct and arrange the suction and discharge pipes and bins that the dredge may be kept properly trimmed and that pumping the material against any material head may be avoided, said bins being decked over in a substantial manner and at such height from the keel of the ship that when the bins are filled with sand their tops are even with the load water-line. Sixteen claims.

799,378. LIFEBOAT. H. J. HEDDERWICK, GLASGOW, SCOTLAND.

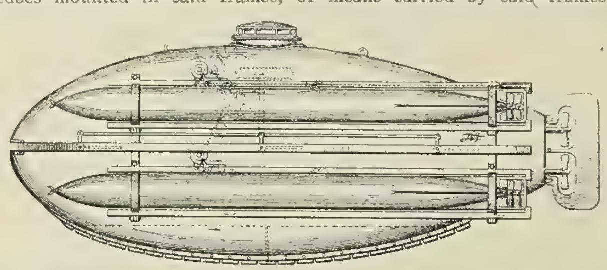
Claim.—6. A lifeboat having end and side longitudinal airtight compartments, in combination with a series of water-charged cases located on one side of the center line of the boat, and a series of cases located upon the



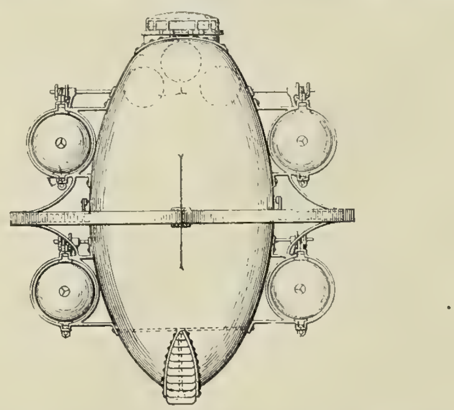
opposite side, provided with top outlets and base inlets fitted with valves, coupled together by a rod, in combination with a series of cases with top inlets and base outlets formed therein located at one side of the boat, together with a series of airtight cases located upon the opposite side of the boat, fitted and arranged for the purposes substantially as set forth. Eight claims.

800,101. SUBMARINE TORPEDO BOAT. JOHN J. HARPAIN, OF THE UNITED STATES NAVY.

Claim.—5. In a submarine boat, the combination with a series of frames grouped symmetrically on opposite sides of and exterior to the boat, and torpedoes mounted in said frames, of means carried by said frames for



locking the torpedoes therein, means operated from the interior of the boat for releasing each torpedo when desired, and spring-actuated means also operated from the interior of the boat for moving the torpedo forward and for setting the motive power of the torpedo in operation.



36. In a submarine torpedo boat, the combination with the hull of the boat of a guard rail mounted exterior to the hull of the boat, a series of immersion rudders pivoted between said guard rail and said hull, tillers for said rudders mounted exterior to the boat, a rod on each side of the boat connected to all of the tillers on that side, and a lever mounted in the interior of the boat and simultaneously operating both of said rods, and ballast tanks and detachable weights for bringing said boat to an even keel, and trimming same laterally. Fifty claims.

Marine Engineering

DECEMBER, 1905.

THE NEW HAMBURG-AMERICAN LINER AMERIKA.

On October 20 the latest and most luxurious of the enormous intermediate steamers which have recently been put into service on the North Atlantic made her first appearance in New York harbor. This ship, which is with a single exception the largest in commission, was partly described at page 276 in our issue of July last, on the occasion of her launching. The main dimensions, which we will repeat from that description, show that she has a length of 670 feet between perpendiculars, 686 feet over all; a beam of 74 feet and depth of 52 feet; the height to the boat deck is 77 feet 6 inches, the displacement, 40,000 tons, and the cargo carrying capacity, 15,000 tons. The gross tonnage is given as 22,724. The ship is propelled by twin screws, actuated by quadruple expansion engines balanced on the Yarrow-Schlick-Tweedy system, and the balancing is said to be so good that scarcely a tremor is felt in any part of the ship due to the action of the reciprocating parts of the engine. The indicated horsepower is a little over 15,000, which corresponds with a sea speed of about 17.5 knots. On her maiden voyage, the *Amerika* covered the distance from Cherbourg to Sandy Hook, 3,050 nautical miles, in seven days, seventeen hours and twelve minutes, this being at the average rate of 16.45 knots.

THE AMERIKA STARTING FOR EUROPE, OCTOBER 26, 1905.

(Photograph, Byron, New York.)

Accommodations are provided for 550 first class, 300 second class, 250 intermediate or third class and 2,300 steerage passengers, which, with the crew of 600 men, makes a total of 4,000 persons on board when all the accommodations are taken. The first class apartments are luxurious in the extreme, and beautifully decorated. A number of imperial suites at the forward end of the lower promenade deck include three to six rooms each, having appointments very similar to what is found in first class hotels. In addition to this feature some of the rooms are of unusual size for shipboard, the largest being 12 by 14 feet in measurement. Other high class accommodations on the upper and lower promenade decks include suites consisting of sitting room, bed room and bath room, the decorations of no two of which are the same, some being in the Empire style, others in that of Louis XVI, etc. It is noteworthy that in no case does any first class state room have an upper berth, and in a great many cases, the lower berths are arranged somewhat in the manner of the berths on Pullman sleeping cars, so that they may be transformed for daylight use into luxurious settees.

Another innovation on this ship, which has already proved a success, and which is bound to be popular with a great many people, is the à la carte restaurant, situated upon the upper promenade deck, which is operated by the proprietor of the Ritz hotel in Paris and the Carlton hotel in London. Passage on the ship may be engaged with or without meals, the latter contingency providing for the use of the restaurant. The accommodation in this apartment is for 120 persons, the idea being an elaboration of the grill room feature on the *Deutschland* of the same line. The restaurant is decorated in the renaissance style with elaborate fittings in chased bronze. The walls are paneled in mahogany and chestnut, mounted in bronze after the style of the eighteenth century. In place of the usual circular port holes are fitted large square windows, while a skylight of artistically stained glass and framed in wrought iron makes the apartment very light throughout the day. At night a soft light is diffused from large crystal electroliers and beautiful ormolu wall brackets. The arrangement of the tables is such that parties of from two to eight will be accommodated at the several tables, while one special table will seat twelve. The chairs are copies of an old Versailles design, with a pattern of tapestry used by Marie Antoinette in the Petit Trianon.

In addition to the à la carte service table d'hôte service will be provided in the main dining saloon, which is on the saloon deck and extends through the full width of the ship for a distance fore-and-aft of 100 feet. This saloon will accommodate nearly 400 people. The walls are pearl gray, hung with copies of Bouché's productions, with carpets and table coverings of old gold. The furnishings are of the Louis XVI period, with

THE SOCIAL HALL AND MUSIC ROOM.

(Photograph, Byron, New York.)

wood carvings reproduced from those in the Grand Trianon.

Other novelties on this ship not usually found on even the largest and latest of the Atlantic liners are the passenger elevator running through five decks; the flower shop on the Roosevelt deck; the candy shop; an unusually complete gymnasium; telephones connecting all staterooms with a central station; an elaborate nursery for the children; electric and hydropathic baths,

THE DOUBLE-DECKED SMOKING ROOM.

(Photograph, Byron, New York.)

THE WRITING ROOM.

and a staff of trained nurses for the use of such passengers as may have occasion to require their services. It might be mentioned at this point that the several accommodation decks in the steamer have been given distinctive names instead of the usual nomenclature employed in such cases. The names, counting from the uppermost downward, are Kaiser, Washington, Roosevelt, Cleveland and Franklin.

THE RITZ-CARLTON CAFÉ, ON KAISER DECK.
(Photograph, Byron, New York.)

One of the most striking features on this ship is the first class smoking room, which has the unusual distinction of running through two decks. Our illustration gives a splendid idea of the general appearance of this room, the upper deck being, as shown, in the form of a broad gallery with an open space in the center, allowing light from the skylight to illuminate both decks. The apartment represents as nearly as possible a great hall or hunting room of an Elizabethan manor house, with solid oak hand-carved and purposely left with the wrought tool marks, to carry out more fully the desired effect. There is a

THE BROAD SWEEP OF THE BRIDGE DECK.
(Photograph, Byron, New York.)

THE MAIN ENTRANCE, STAIRWAY AND FLOWER SHOP.
(Photograph, Byron, New York.)

huge Elizabethan fireplace with a stone hearth. The upholstery in this apartment is as usual very plain and of leather, it being the purpose to retain no more of the odor of tobacco than can be helped. The artificial lights consist in incandescent lamps mounted in conventional ships' lights; and the effect is very pleasing.

At the after end of the Kaiser deck is the ladies' cabin, social hall and music room, which is a very spacious apartment, beautifully decorated, and lighted by large square windows and an octagonal skylight let into the center of the ceiling. An open fireplace on the after side of this room is one of the features, while directly opposite it is a full length life-size painting of Emperor William II. Four bookcases contain the larger part of the passengers' library. Just forward of this room on the starboard side is the writing room, which is very tastefully fitted up and contains a number of paintings. The staircases throughout the first cabin apartments are most elaborate and have very easy ascents. The metal balustrades are very tastefully designed, and in some cases where the stairway is broad an auxiliary balustrade is carried down the center. One of our illustrations shows this effect, as well as the great size of the main entrance hall for first cabin passengers, while in the background of the same view is seen the flower shop above mentioned. The promenade space has been very carefully worked out, and in many parts of the ship are found large areas for steamer chairs, and in some cases areas sufficiently large to be used for dancing.

The equipment of the ship includes, besides the above mentioned features, a number of others now seen in all the latest first class ships, such as Marconi wireless telegraph system, a splendid system of ventilation by means of which the air in all the rooms is completely changed at very short intervals of time, submarine bell signals to give warning of approaching dangers, a large number of transverse bulkheads with the

THE AMERIKA AT SEA.

THE STAIRWAY FROM KAISER TO BRIDGE DECK.

Stone-Lloyd system of watertight doors, the doors being automatically closed from the bridge by means of a single handle, the Dayton automatic fire extinguisher apparatus, filtering apparatus and a system of hot and cold fresh water supply throughout the ship.

THE NURSERY.

The ship, as a whole, reflects great credit upon her builders, Harland & Wolff, of Belfast; upon her decorators, and upon her owners.

THE MANXMAN AT 23 KNOTS.

RECENT TURBINE STEAMERS.

Great activity has been evident during the past two years in the construction of turbine steamers, and from recent tests made there seems to be every reason to believe that turbine-driven vessels will be extensively used in the future.

THE MANXMAN.

One of the accompanying illustrations shows the triple-screw steamer *Manxman*, which is equipped with Parsons steam turbines, and has made a speed of over 23 knots. She was constructed by Vickers Sons & Maxim, Ltd., at Barrow-in-Furness, and has a total length of 330 feet on the water-line, a depth of 25½ feet with four decks, and a molded breadth of 43 feet. She is provided with three sets of turbines, consisting of a high-pressure turbine operating the center shaft, and two low-pressure turbines driving the two side shafts and propellers, the latter being also connected to two astern-driving turbines which take the steam direct from the boilers. In an official trial of six hours, with the low-pressure turbines operating at 590 and the high-pressure turbine at 520 revolutions per minute, a mean speed of 22.65 knots was obtained, the vacuum being 28.5 inches. Since the official test, trials have been made showing a mean speed of 23.141 knots with a boiler pressure of 192 pounds, the pressure at the center turbine being 180 pounds and at the two low-pressure turbines 20 pounds per square inch; the speed of the latter was 609 and of the former 533 revolutions per minute.

The *Manxman* is heated by the thermo-tank system installed by the Thermo Ventilating Company, of Glasgow, Scotland, which is said to have given excellent satisfaction, producing the required heat in fifteen minutes with an exceptionally small consumption of steam, while tests have shown, it is stated, that three hours would be required to attain the same temperature by the ordinary steam-heating system. The steamer was constructed for the Midland Railway Company's steamship service for the Isle of Man traffic, which requires large saloons and promenade spaces. The shade deck is used exclusively as a promenade, and the promenade deck is especially designed with wide spaces on each side for use in a similar manner. The dining room, which takes the full width of the vessel, has a capacity for seating 100 passengers.

The boiler equipment includes one single-ended boiler 11 feet 6 inches long and 15 feet 7 inches in diameter, and two double-ended boilers 22 feet long and of the same diameter, the former having three furnaces and the latter six furnaces, with heating surfaces of 2,493 and 4,984 square feet respectively. The single-ended boiler has 80 square feet of grate area, and the double-ended boilers 161 square feet each; the total grate area being 402 square feet, and the total heating surface 12,461 square feet.

KING EDWARD'S NEW STEAM YACHT.

The new steam yacht for King Edward VII is being built by Messrs. A. & J. Inglis, Glasgow, who received the order in competition with a number of shipbuilders. Messrs. Inglis submitted a model showing the form of the hull and the general appearance of the vessel, and a drawing showing the yacht at sea. The various tenderers were invited to submit designs, and were left very much to their own discretion in the planning of the vessel, except that they were informed of the general dimensions and the draft required. The yacht is to be considerably smaller than the *Victoria and Albert*, and of a draft sufficiently light to enter ports into which the larger vessel cannot go, such as Flushing and Nice. She is to be fitted up for the royal family and their private suite, and not for large parties of guests, and it was stipulated that she was to have turbine machinery.

Messrs. Inglis' design was picked out very early as especially suitable, and when submitted to the king met with his approval. They proposed to build a vessel 285 feet in length on the load water-line, 40 feet in breadth, of 2,000 tons gross, propelled by three Parsons turbines driving separate shafts, with one propeller on each shaft, and having a speed of 17 knots. They also submitted designs for the internal arrangements of the vessel. The new yacht will replace the *Osborne,* and will be 137 feet shorter than the *Victoria and Albert,* and of less than half the tonnage.

THE OSTEND-DOVER STEAMER PRINCESSE ELISABETH.

The fleet of the Ostend-Dover line is composed of nine large steamers having trial speeds ranging from 19 to 22 knots. The older and slower ships are being constantly replaced by faster ones. The latest addition is the turbine steamer *Princesse Elisabeth,* which was put in service at the beginning of October. The arrangements for luxury and comfort of the travelers on this steamer surpass the best that has been provided heretofore for this type of ship.

The forward end of this deck is occupied by the anchor gear with capstan and the aft end by a steering engine and capstan.

The second deck shelters the large restaurant, seating 120 people, the galley and lavatories of the first-class passengers. At the rear, besides engine and boiler spaces, are quarters for stokers, the state rooms for the principal officers, together with store rooms and stairway leading to the second-class apartments. The lower deck has at the forward end quarters for sixteen stewards and cooks, various quarters for first-class and second-class passengers, and at the rear a second-class smoking room with buffet, second-class ladies' parlor, and crew's quarters.

The total equipment provides for the carrying, besides the crew of seventy persons, of about a thousand passengers. All these saloons are fitted up very comfortably and those of the first-class very luxuriously. The decoration of the first-class dining saloon includes twelve allegorical panels painted on linen and repre-

STEAMER PRINCESSE ELISABETH AT FULL SPEED.

senting the twelve months. The ceiling is of wood decorated and painted in imitation of antique bronze. It is subdivided into panels where the electric lights to the number of thirty are let down. The floor is covered by Brussels carpet.

The *Elisabeth* has a length over all of 357 feet, a beam of 40 feet, a depth to promenade deck of 23 feet, and to bridge deck of 30 feet. The machinery is composed of three compound steam turbines of the Parsons type, each operating a single screw. One of the turbines receives high-pressure steam and the other two low-pressure, the total power developed being about 10,000 horse-power. There are turbines likewise provided for running backwards. The propellers are of bronze cast in a single piece. There are eight cylindrical tubular boilers arranged in two groups of four each with two transverse fire rooms. The boilers are operated at a pressure of 150 pounds per square inch, and use forced draft on the Howden system.

The hull was constructed of mild steel and contains a lower deck, second deck, upper deck, promenade deck, and bridge deck. The bridge deck, which serves as a shelter for the upper deck, is accessible to first-class passengers for promenade purposes. This deck has, besides the pilot house, the captain's cabin and the Marconi wireless station, and lifeboats six in number, and two small boats. These boats are all launched by means of special Welin quadrant davits, which permit rapid action, due to the fact that a movement of oscillation is employed instead of one of rotation.

The upper or promenade deck is occupied for nearly two-thirds of the length by a steel deck house, containing from forward to aft respectively the smoking room, the ladies' parlor, the companionway to the dining hall and first-class accommodations, twenty first-class state rooms, two state rooms de luxe, and a royal saloon, without mentioning the two funnels and casings.

The smoking room, which is so placed as to give the passengers a good view of the sea, is treated very severely but comfortably. The walls are of Hungarian oak polished in natural color. The companionways and stairs giving access to the first-class apartments are decorated likewise quite severely in wood, with inlaid floors, and passageways lined with linoleum. All of the quarters are splendidly heated and ventilated, the heating being by steam on the system known as "thermo-tank." This system consists of two pieces of apparatus situated upon the bridge, each composed of a steam heater and a ventilating fan operated by an electric motor, and permits the withdrawing of vitiated air and supplying of fresh air to each apartment. The air is distributed by means of pipes running along the ceilings and walls.

The electric installation on board consists of two generators, of which one is used to supply current to the motors operating ventilators and to the small fans in the saloons. The second serves for supplying current to a powerful searchlight and for all lights on the ship. The latter number more than 300 incandescent lamps. The two generators are identical and interchangeable and each is operated by a small direct-connected steam turbine. Telephonic connection is maintained between pilot house and the engine room, while the wireless telegraph apparatus already mentioned is taken care of by means of power from one of the generators, the receiving wires being strung from the masts

THE MAHENO MAKING 17.5 KNOTS ON TRIAL.

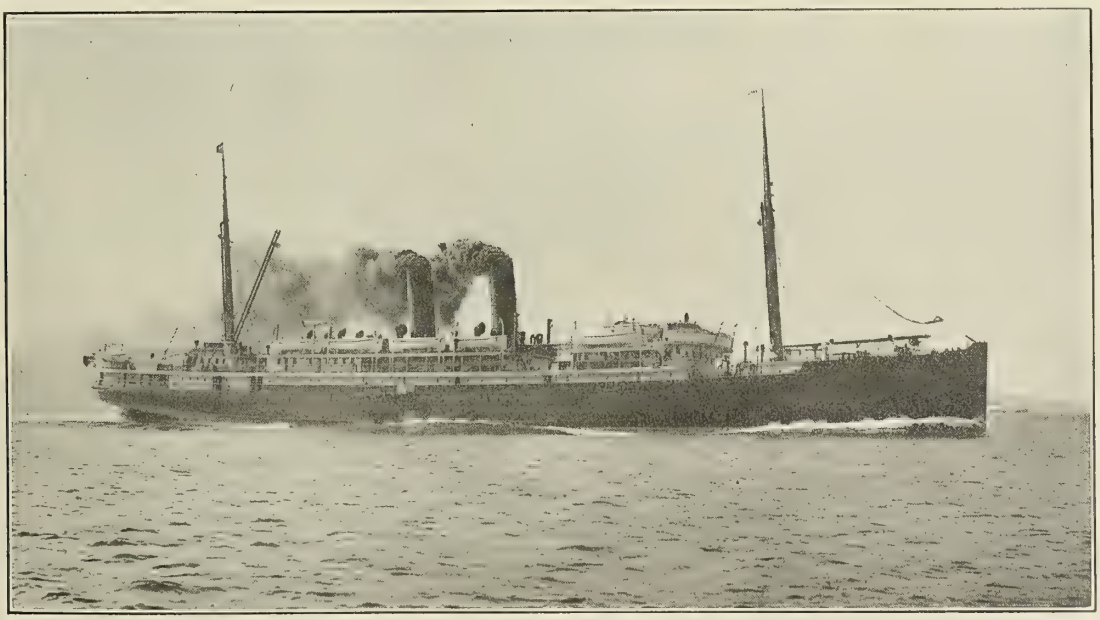
The *Elisabeth* has shown herself to be the fastest of all the boats in service between England and the Continent, for she has attained a speed of 24 knots during a trial trip of four hours, this being 1½ knots greater than the speed guaranteed by contract. The speed attained in a rearward direction reached 16 knots in place of the guaranteed 13. The nautical qualities shown by the ship on trial trip and since in service have given perfect satisfaction, particularly the facility with which she answers the helm. The vibrations are so insignificant that it is difficult to tell when within the ship whether she is moving or not.

A TURBINE STEAMER FOR THE PACIFIC.

William Denny & Brothers, Dumbarton, Scotland, have constructed for the Union Steamship Company, of New Zealand, a new triple-screw turbine vessel named *Maheno,* of which we present two photographs, taken on her trial trip at the end of September. This vessel is intended for the inter-colonial trade, as well as for the long run between New Zealand and Vancouver, B. C. The dimensions are 400 feet by 50 feet by 38 feet 6 inches deep, and she was built to the rules and under the special survey of the British Corporation. The entire main deck, together with a large central house on the upper deck, is devoted to the accommodation of passengers, of whom about 225 first-class and 120 second class will be carried. There is also provision for about sixty third-class passengers when the vessel is on the Vancouver run.

The first-class passenger accommodation is in the midship portion of the vessel, and is mostly in three-berth rooms, which are fitted with special conveniences devised by the company from their long experience in this trade. The dining saloon, at the fore end of the midship deck house, is framed in fumed oak, with ground treated in reeded oak, stained green. Two long tables provide dining accommodation for the majority of the passengers, and a number of small tables are located at the sides. There is an organ at the fore end of the saloon, and large sideboards at the after end, framed in harmony with the general design. The saloon is lighted at the front and sides by large rectangular brass-framed windows, and also by a dome above. Ventilation is secured by large flail fans on the ceiling. The upholstery is in green and gold moquette, and the floor is laid with red Wilton carpet.

The music room, on the deck above, is of Adams design in white

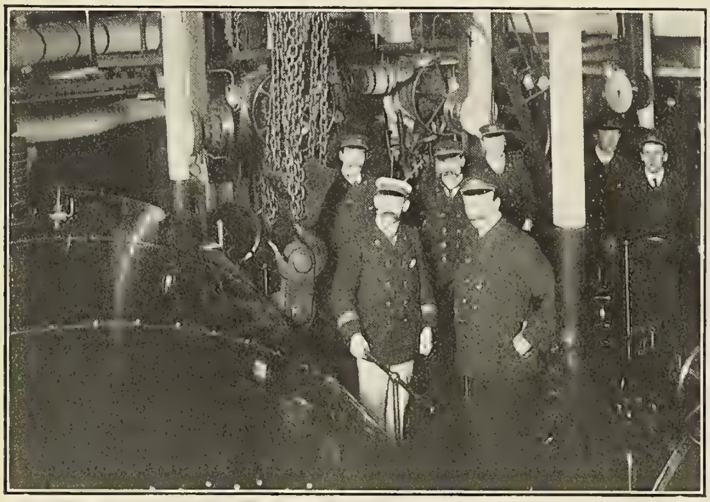


THE PACIFIC STEAMER MAHENO AT FULL SPEED.

enamel with gold silk panels. The ceiling, which is flush with the under side of the beams, is in Tynecastle tapestry. A central ottoman is fitted round the dome to the dining saloon, and there are a number of cosy corners luxuriously upholstered, and artistically screened from the rest of the room. The piano is a Bechstein grand, in dark mahogany to match the rest of the furniture. A feature of this apartment is the leaded glass, which together with the rest of the decorative work of the vessel has been entirely carried out in the builders' yard.

The smoking room, situated on the shade deck, forward of the turbine hatch, is framed in Burmese padouk, a simple classic design being adopted to display the rich figure of this wood. There is a high dome above the smoking room lined in anaglypta, with a tier of clerestory lights in stained glass. The frieze represents ancient war galleys, in relief. The main vestibules are framed in walnut with satinwood panels. Large oval mirrors are worked into the design with richly carved spandrils.

The accommodation provided for second-class passengers is of less elaborate design, but is very little short of the first-class in the matter of comfort and convenience.



ENGINE ROOM OF ALLAN LINER VICTORIAN.
(Photograph, Richards, Montreal.)

The *Maheno* is lighted throughout by electricity, for which there is duplicate plant. A refrigerating installation on the ammonia system is fitted both for cargo and for ship's use. The cargo gear consists of hydraulic hoists, working double derricks at each hatchway. The steering is effected by means of a steam tiller aft, controlled from the flying bridge by telemotor. A powerful windlass with warping ends and a warping winch in the wheel house aft enables the vessel to be expeditiously moored in harbor. The fire-extinguishing appliances consist of a fire system of galvanized pipe and hose, kept in glass-fronted lockers at various stations throughout the vessel. In addition to this, the Clayton system of fire extinguishing by means of sulphur dioxide is installed, and provision is made for fire extinguishing by steam.

The vessel is propelled by a set of Parsons patent turbines, constructed by Messrs. Denny & Co. There are three turbines, one high and two low-pressure, working three shafts, with three propellers in all. The go-astern turbines are contained within the low-pressure, and work on the wing shafts. The reversing gear is particularly well arranged, the whole of the engines being easily controlled by one engineer. Steam is supplied by four cylindrical tubular boilers, two double ended and two single, at a working pressure of 150 pounds per square inch, and fitted with Howden's system of forced draught. The auxiliary machinery is very complete, and consists of air and circulating pumps to each main condenser, each set consisting of two Edwards air pumps and one centrifugal pump, driven by simple two-cylinder engines; two of Weir's feed pumps, auxiliary condenser with necessary pumps, two large duplex pumps for bilge and ballast purposes, a Caird & Raynor distiller, and a vertical duplex wash deck and fire engine, suitable for working See's ash ejector, sanitary pump, steward's pump, water-service pump, oil pumps, etc. The mean speed for six hours was 16.4 knots, with two-thirds of the boiler power only.

MOTOR BOATS, VI.

BY DR. WILLIAM F. DURAND.

THE BOAT.

The general problem of the motor boat has been already stated in the first of the present series of articles. Since this introductory development of the problem, as a whole, we have been concerned with the second of the three main divisions, the problem of the motive power.

We are to turn now to the first division as previously classified, the problem of the boat as to form and structure.

The problem thus approached naturally divides into two parts:

(1) The selection of such proportions and such form of hull, having due regard to carrying capacity, comfort, seaworthiness, etc., as shall insure the minimum resistance at the designed speed, and thus permit of realizing such speed with the minimum power, or the maximum speed with a given power.

(2) With given form and dimensions and with due regard for strength, to construct the boat with the minimum weight of structural material, thus allowing the maximum share of the total displacement for carrying capacity and for machinery.

Taking all conditions at the extreme limit it follows that the motor boat of the highest attainable speed will show, on given dimensions, the lightest construction of boat consistent with the needed strength, a form suited to the highest speeds within the range of hope, and the maximum power developed on the fraction of displacement allotted to this purpose. For more moderate cases the boat may be made stiffer and stronger, fuller in form and with higher freeboard, giving greater roominess and carrying capacity (all conducing toward seaworthiness and general safety), combined with a generally heavier style of machinery construction conducing toward longer life and decreased expense for maintenance. These various desirable features are of course realized at the expense of some reduction in speed, and the result becomes a general compromise, as, in fact, all examples of engineering design of necessity are.

We shall postpone to a later point the discussion of structural features, and shall now proceed to a consideration of the factors which enter into (1) as above specified—the determination of such forms and proportions as will conduce to minimum resistance with an acceptable combination of other elements.

Resistance.—The resistance of any boat-formed body moving through the water may conveniently be divided into two parts:

(1) The skin effect or so-called skin friction. This part of the resistance depends primarily on the extent and character of the wetted surface of the boat and on the speed, and increases a little more slowly than with the square of the speed.

(2) The wave effect or part which is manifested as surface disturbance. This part of the resistance depends chiefly on form, proportion and speed, and varies with the speed by an index which lies usually between 3 and 4.

At low speeds the larger part of the resistance falls under class (1), and if low speeds alone were required, the form and proportions adopted would be such as to give a small wetted surface relative to the size of the boat. This would result in a relatively short, broad, deep model, rounded in form somewhat like an elongated hemisphere, and with a boat-formed bow and stern. As the speed advances, however, the wave-making resistance becomes more and more predominant, and at high speeds it takes first place, forming more than one-half the total resistance. If in some extreme case wave making could be imagined as the only form of resistance, the ideal boat form would be then reduced as nearly as possible to the proportions of a vertical plane. Such a boat would show an excessively narrow beam for the length, with knife-edge bow and stern. Actually, however, skin resistance is always present, and in any case a compromise is effected in accordance with the special circumstances in hand. Thus for moderate speeds a fairly large proportion of beam to length is permissible, with form moderately well filled out at bow and stern. As the demand for speed increases so must the proportion of length to beam increase, and coupled with increasing fineness of form at bow and stern, worked out in accordance with considerations to be discussed at a later point.

tinuously with increase in designed speed, and only for the lowest speeds can the lower values of this ratio be considered acceptable. Thus in the practice of the day actual values of this ratio are found between 5 and 10. The latter represents about the extreme value practicable under existing conditions regarding strength and space required for machinery. There is good reason to believe that still narrower boats would show excellent results at high speeds so far as considerations of resistance are concerned, but strength and room for machinery are obtained with continuously

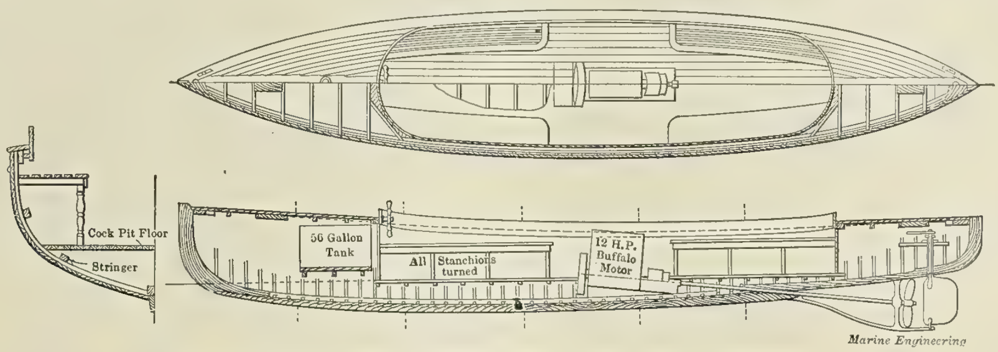


FIG. 33.—INBOARD PROFILE, SECTION, AND PLAN OF A SMALL MOTOR BOAT.

The actual proportions and form of a boat must, however, to some extent be determined in recognition of the internal space required for the proper installation of the machinery, while qualities relating to safety, seaworthiness, etc., demand likewise some recognition in the final combination. In particular, considerations of this character usually force the selection of a greater breadth of beam or greater proportion of beam to draft and length than would be otherwise selected for the higher range of speeds.

It may be well to note at this point that while the terms high speed and low speed are arbitrary in themselves, there are general limits in the relation of speed to length above and below which the terms high and low may fairly be applied. Roughly speaking, this limit measured in knots is close about the square root of the length in feet, higher as the beam is narrower and form is finer, and lower in the inverse cases. Thus for a boat 25 feet long any speed above 5 to 6 knots will be high in the sense that wave-making resistance will be of some considerable importance, and the entire design of the form of the boat must be carried out with this fact in view. Likewise, for a larger craft 60 feet in length, speeds much above 8 knots or, perhaps, from 10 miles per hour upward, will produce such surface disturbance as to demand recognition in the design of form. From these

increasing difficulty as the beam is decreased in proportion to the length. Thus a boat 4 feet beam and 50 feet in length would doubtless show excellent results, so far as resistance is concerned, when pushed to speeds of 20 miles per hour or above, but such proportions would tend to render the boat flexible and, perhaps, unsafe in a seaway, and such beam would give quite insufficient width for the proper installation of the machinery suited to the development of the speed. In short, if the high speeds at which it is proposed to drive the boat might justify some such proportion of length to beam so far as resistance is concerned, the fact remains that the space demands of the machinery required to realize the speeds will not permit it. It thus results that ratios of 9 to 1 or 10 to 1 represent about the upper practicable limit under present conditions of engineering practice.

From these upper extremes we come down through all gradations to lower limits of 4½ to 1 or 5 to 1, found only in very short boats or in longer boats designed for low speeds, and which are intended to be roomy and large in carrying capacity or in which stiffness and safety in a seaway are of special importance. The general class of moderate-sized boats intended for fair speed, and with some consideration paid to matters of capacity and general comfort, show a length of 5½ to 6 or 7 beams. Lengths

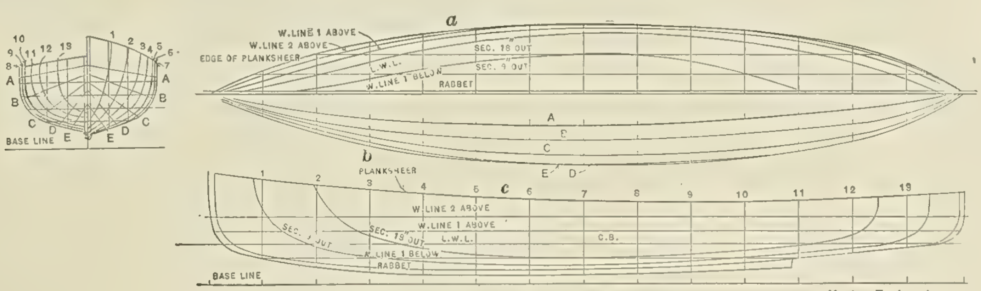


FIG. 34.—LINES AND BODY PLAN OF A SMALL MOTOR BOAT.

proportions it is easily seen that practically all motor boats are run at speeds which are high in the sense in which the term is here used. Few boats are less than 16 or 18 feet in length, and for the average small boat up to 40 or 50 feet in length speeds of 7 to 9 or 10 miles per hour are considered the minimum acceptable.

Referring again to the relation of length to beam, it is clear from what has been said above that so far as resistance alone is concerned the ratio of length to beam should increase con-

in excess of the higher figures indicate some special attention to high speed, and with other qualities sacrificed in some measure as the price to be paid for its attainment.

The proportion of beam to draft is of less relative importance, so far as resistance is concerned, than that of beam to length. Generally speaking, reduction in beam may go hand in hand with increase in draft, and thus the narrow, deep model forms a natural combination as well as its opposite, a broad, shallow form. For the usual type of motor boat it will be safe to select what may seem to be a suitable proportion of length to beam, and then allow the draft to be determined by the resultant weight conditions of the boat.

We may now turn to the question of the form of the boat, first for the underwater body and second for the part above the water-line. Naturally the characteristics of form will depend much upon the various other special requirements of the case, and especially upon that of speed. We may, therefore, with advantage take for first consideration boats of the highest speed and note the characteristics of form which tend toward its most effective realization. Naturally, furthermore, this is by no means a matter in which all opinions are in accord. Differences in both theory and practice exist among the best designers and builders growing out of different views regarding the relation of the various elements going to make up boat resistance, and out of differences in experience in connection with problems of actual design. The following suggestions, however, contain the points generally agreed upon, and represent the general consensus of view regarding the best combination of form characteristics suited to the development of high speeds.

Forms showing a short, vertical cutwater with well rounded forefoot and keel line, gradually sloping thence down to full draft at a point farther aft, cannot be recommended. Length on the water-line is always of importance, and with any such form of cutwater and forefoot there will be a serious loss of effective length of water-line, especially at high speeds or under any condition which may involve a lifting of the bow somewhat above its normal trim. It is of small use to build a boat 40 feet on the water-line if at the highest speeds the bow may rise and shorten the effective length to 35 or even 30 feet. This fault has been noted in some cases of recent so-called "auto-boat" design, and it is one to which designers may well pay special attention.

For the after body the popular torpedo boat model shows for the immersed part of the boat a gradually tapering wedge with edge at the stern, horizontal in line and at the surface of the water. That is, assuming the upper part of the boat cut off by a plane at the water surface, the remaining part would show such a wedge-shaped form, its base joined to the forebody, and with its lower surface sloping easily upward to the horizontal edge at the stern, and lying at the surface of the water. The

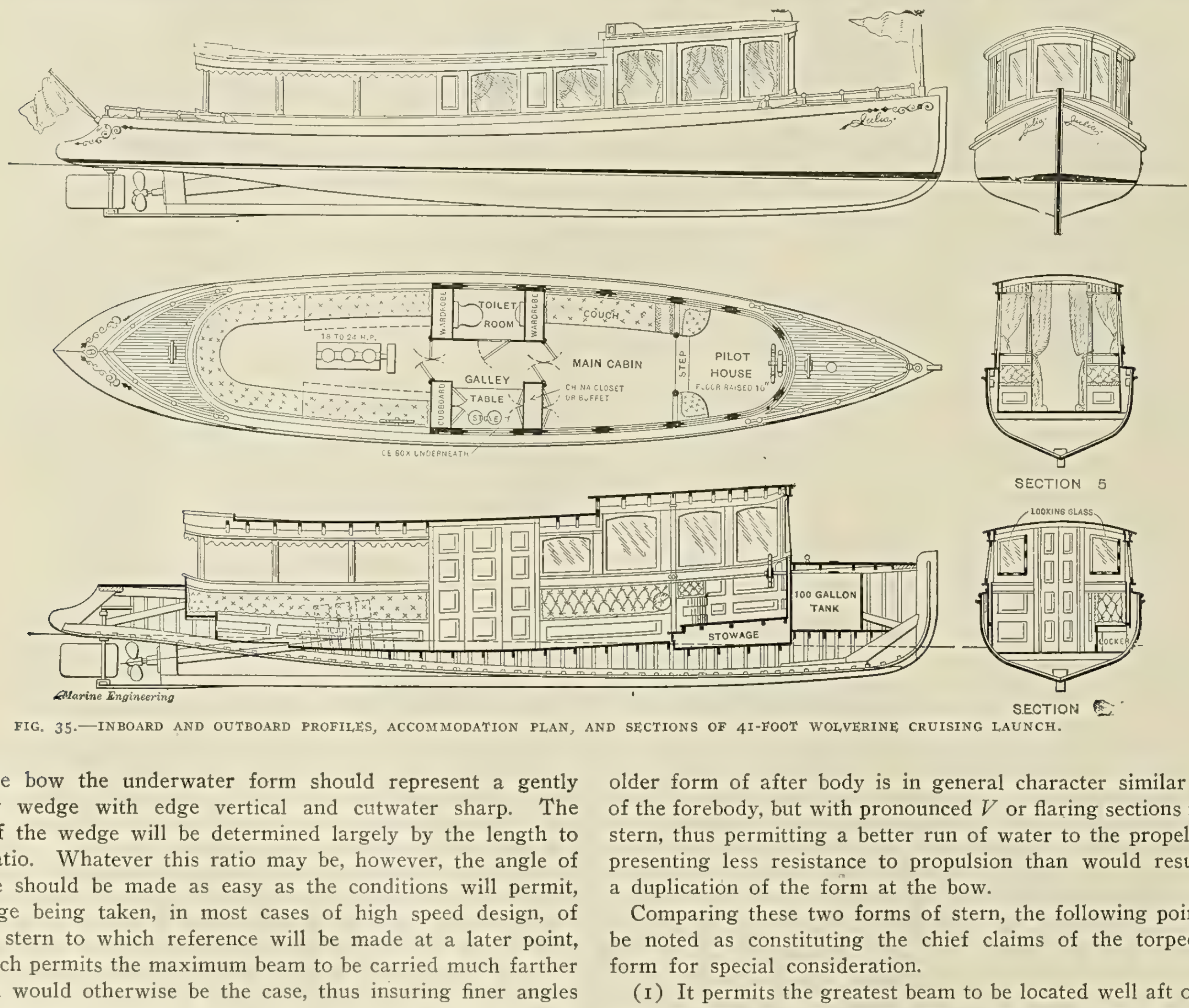


FIG. 35.—INBOARD AND OUTBOARD PROFILES, ACCOMMODATION PLAN, AND SECTIONS OF 41-FOOT WOLVERINE CRUISING LAUNCH.

At the bow the underwater form should represent a gently tapering wedge with edge vertical and cutwater sharp. The angle of the wedge will be determined largely by the length to beam ratio. Whatever this ratio may be, however, the angle of entrance should be made as easy as the conditions will permit, advantage being taken, in most cases of high speed design, of the flat stern to which reference will be made at a later point, and which permits the maximum beam to be carried much farther aft than would otherwise be the case, thus insuring finer angles of entrance than with maximum beam amidships. Regarding the form of sections at the bow, both *U* and *V* shapes are used, but the former may fairly claim the preference, especially as regards wave-making resistance. The lifting effect at the bow is also less pronounced, and there is less disturbance to the trim at high speeds with *U* than with *V* sections. A certain amount of bodily lifting of the boat at the highest speeds with the consequent reduction in wetted surface and in resistance is, of course, to be desired. This may, however, be better determined by a suitable adjustment of the form somewhat farther aft, and the lifting effect thus located will produce but slight change in the trim at operating speeds.

older form of after body is in general character similar to that of the forebody, but with pronounced *V* or flaring sections near the stern, thus permitting a better run of water to the propeller, and presenting less resistance to propulsion than would result with a duplication of the form at the bow.

Comparing these two forms of stern, the following points may be noted as constituting the chief claims of the torpedo boat form for special consideration.

(1) It permits the greatest beam to be located well aft of amidships, thus insuring finer water-line or entrance angles at the bow.

(2) It places the surface of the boat at the stern in the best possible position to find support from the water pressures in that locality, such upward pressures effectively resisting the tendency to settle at the stern so commonly shown by small boats at high speeds, and which may so seriously disturb their running trim.

(3) The entire absence of deadwood places the propeller still more satisfactorily in the direct run of water under the stern, and thus contributes to its effective operation as an instrument of propulsion.

(4) On the same over-all dimensions it gives more water

plane area than the common ship-shaped form, and thus more stiffness against heeling, more stability, and more safety so far as the latter may depend on these characteristics.

(5) For the same reason as in (4) the part of the boat above water may be made more roomy at the stern, thus adding to the comfort and general serviceability of the boat.

On the other hand the following two points must be set as disadvantages over against the preceding desirable qualities:

(1) The large amount of nearly flat, horizontal surface at the stern tends to render the boat uneasy in a seaway, and may result in severe pounding. It is, in fact, generally agreed that for service in rough weather this form of stern is somewhat inferior to the older or ship-shaped model.

(2) The absence of deadwood places the propeller as it were out in the open, and thus exposed to damage from floating drift or in case of grounding.

Mention may be made at this point of the possibility of so adjusting a stern overhang that the water-line length when the boat is at rest shall be considerably less than when under way. The rating of boats for regatta purposes naturally includes the water-line length as an important factor, and such a form of design may result in the location of a boat in a lower rate than that in which she might belong if measured when running at a high rate of speed. An overhang carrying out the general form of the stern and located just clear of the water when at rest will be brought down by a small change of trim due to slight settling at the stern, and will thus form a part of the effective length of the boat. This is a matter primarily of jockeying, and has no relation to the scientific basis of boat design. The length for rating should in fact be determined on the water-line when running at top speed, and with such method of measurement there would be no further temptation to resort to such methods of gaining an advantage in measurement rating.

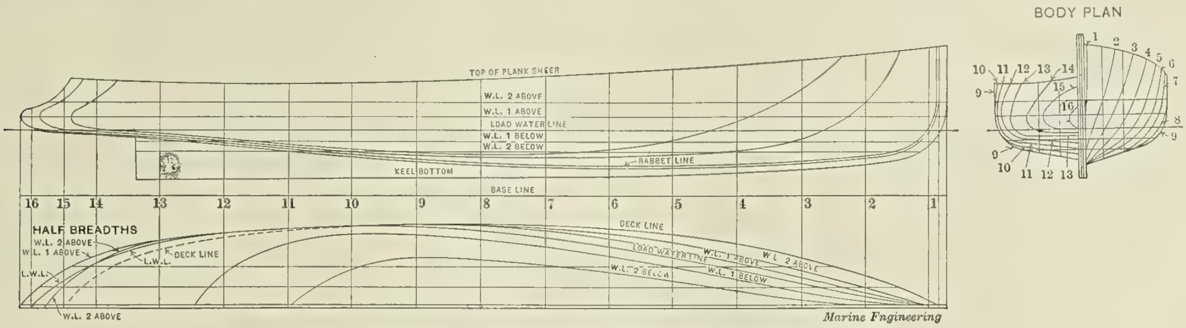


FIG. 36.—LINES AND BODY PLAN OF WOLVERINE CRUISING LAUNCH.

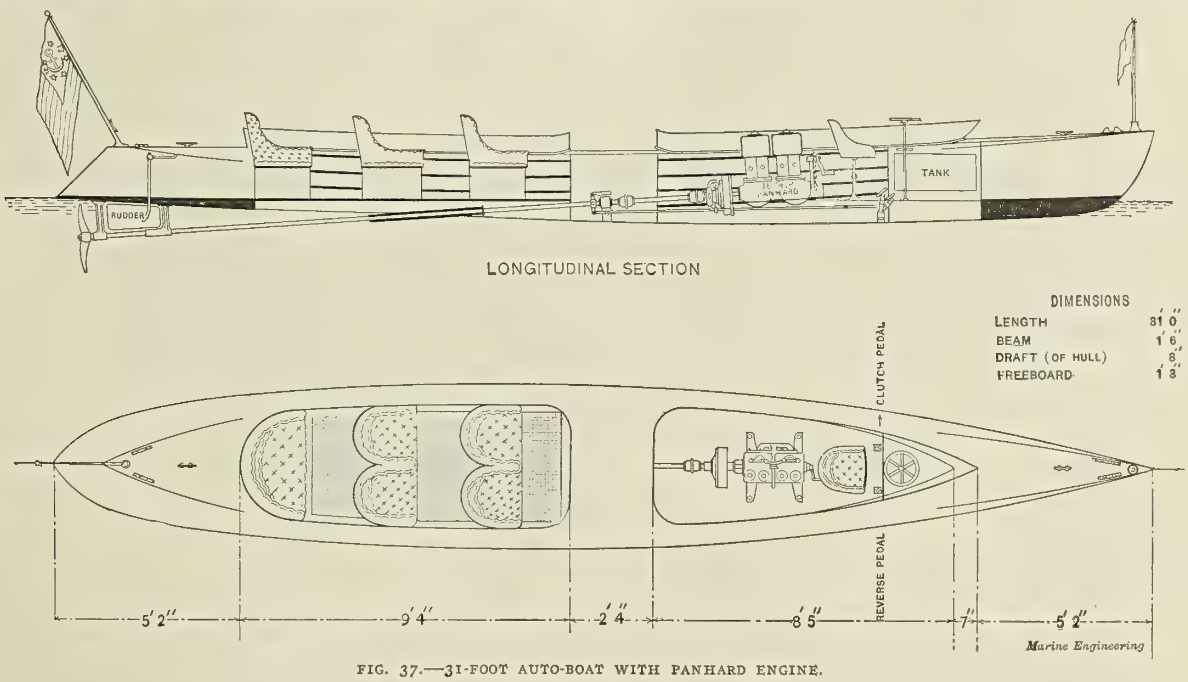


FIG. 37.—31-FOOT AUTO-BOAT WITH PANHARD ENGINE.

Quite aside from the question of rating the form at the stern should be so adjusted with reference to the weight schedule and to a suitable location of the machinery and other weights, that at top speed the lower knuckle or under surface of the boat at the stern will nicely settle to the surface of the water, and without tendency to sink lower and drag or plow a furrow, as is too frequently the case with sterns of this form when improperly adjusted for trim.

With regard to the midship section, the general form for the older ship model shows usually a rather sharp rise from the keel, approaching in many cases to the so-called peg-top form. As compared with a flatter and more nearly rectangular form of section this form has the effect of increasing the draft for the same total displacement, and of thus improving the seaworthiness of the boat in rough water, or of insuring a suitable immersion of the propeller at the stern without too great a drop of the skeg below the keel line.

For the torpedo boat or flat-stern model the midship section is more nearly flat on the bottom, and is thus more full in form than the typical section for the ship-shaped model.

These various characteristics in either form when combined with a pronounced longitudinal paring away resulting in a distributed leanness or fineness of form, provide the conditions most suitable for the highest speeds, especially with reference to wave-making resistance. As the demands for speed are less pronounced the form will respond by becoming fuller at all points, and especially along longitudinal lines, thus giving more internal capacity and more displacement on the same over-all dimensions and proportions.

Between the full flat torpedo-boat form and the ship model are found various "compromise" forms partaking in varying degrees of the qualities of both. The main purpose of such forms is to retain in good measure the characteristics and qualities of the flat model, and at the same time to provide a form somewhat better adapted to rough-water conditions.

Considerations of space forbid any further discussion of underwater form, and in no case can the preceding be considered as more than a general indication of the lines along which designers are working, especially when high speeds are of primary importance in the schedule of required qualities.

In general the flat or torpedo-boat stern represents the typical form for modern motor boats, and especially for all cases in which high speeds form an important consideration. On the other hand, the older type of stern may often be preferred for lower speeds or for cases which may be influenced by special conditions of the service required, while intermediate between the two, various types of compromise form are to be found, dependent on special conditions of the service or on the fancy of the designer.

concerned, as the six cruisers of our *California* class, of which four have been tried, and the battery power and armor proposition seem to have been taken care of about equally well in the two classes of ships. The English ship, however, has a very decided advantage in the question of speed, not only in absolute speed due to a higher power available from the engines, but in the economy of obtaining that speed as well.

A full power trial, lasting eight hours, was had a short time ago, in which the *Drake* averaged 24.3 knots on an expenditure of 31,700 horsepower. Figuring this up by means of the Admiralty formula, we find that her Admiralty constant for the trial in question was 261.

The full power trials of the four ships of the *California* class tried to date gave an average for the four of 26,864 horsepower, corresponding with a speed which averages 22.303 knots, at a displacement averaging 13,760 tons. The Admiralty constant obtained as before is 237.

If we could apply the *Drake's* Admiralty coefficient to the American ships the power required for the speed obtained in the American ships would have been only 24,400, or a saving of nearly ten percent. If, on the other hand, the American ships,

THE ENGLISH ARMORED CRUISER DRAKE.
(Photograph, Levick, New York.)

Armored Cruiser Drake.

By long odds the most important and most interesting of the six ships constituting the Second Cruiser Squadron of the British Navy, which visited New York during the month of November, is the flagship *Drake*. This ship, which was laid down in April, 1899, at the Royal Dockyard in Pembroke, and launched in March, 1901, has a length between perpendiculars of 500 feet; over all, 529 feet 6 inches; a beam of 71 feet, and a mean draft of 26 feet, with a corresponding displacement of 14,100 tons. Her indicated horsepower under the design was 30,000, corresponding with a speed on eight hours' trial of 23 knots. The coal capacity on normal draft is 1,250 tons, with a total bunker capacity of 2,580 tons. The machinery consists of two sets of four-cylinder triple expansion engines, balanced on the Yarrow-Schlick-Tweedy system, and operated by steam from forty-three Belleville boilers fitted with economizers, and having a total heating surface of 72,000 square feet, and grate surface of 2,313 square feet. The *Drake* is of about the same size and date, so far as design is

with their own Admiralty coefficient, had sufficiently powerful machinery to be brought up to the speed which the *Drake* actually attained, the power required would have been 34,800, or about ten percent greater than in the case of the *Drake*.

If, again, the American ships, with the same power as was actually obtained, could have had the *Drake's* Admiralty coefficient, the speed would have figured out at 23.02 knots, or nearly three-fourth knot in excess of the present figure. Whether the discrepancy is due to less well designed lines of hull, or whether it is due to propellers not so well designed, is a question which cannot be settled offhand. It is worthy of note, however, that the *Drake's* speed with her present propellers, which are of much larger blade area than were the ones originally fitted, but of the same pitch, is 1.25 knots better than was the case with the old propellers.

The *Drake's* battery consists of two 9.2-inch guns mounted in single turrets on poop and forecastle; sixteen 6-inch guns, 45 calibers long; fourteen 3-inch guns; a number of machine guns, and two submerged torpedo tubes.

THIRTEENTH ANNUAL MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

The thirteenth annual convention of the Society of Naval Architects and Marine Engineers was held in New York on Thursday and Friday, November 16 and 17, 1905.

The first session was called to order on Thursday at 10.25 A. M., with the president, Francis T. Bowles, in the chair. The report of the secretary-treasurer was received and adopted. The statement of resources and liabilities show that the Society's finances are in excellent condition. The total resources are $24,490.50; liabilities *nil*. The council presented lists of applicants for admission to the various grades of membership; the names were read, and upon motion the applicants were unanimously elected. The membership of the Society on November 15, 1905, was 866. The new members are:

Life Associate, 1.—Alva C. Dinkey, president, Carnegie Steel Co., Pittsburg, Pa.

Members, 14.—Thomas Andrews, Jr., assistant manager and naval architect, Harland & Wolff, Belfast, Ireland; James Edward Davidson, assistant general manager, James Davidson, shipbuilder, Bay City, Mich.; Harold Arthur Everett, instructor in naval architecture, Massachusetts Institute of Technology, Boston, Mass.; Marley F. Hay, superintending constructor, Electric Boat Company, 11 Pine street, New York; Oliver Zell Howard, marine engine and boiler draftsman, and instructor in mechanical drawing in the department of marine engineering and naval construction, U. S. Naval Academy, Annapolis, Md.; Edward C. Johnstone, general superintendent and chief draftsman, Mosher Water Tube Boiler Company, 1 Broadway, New York; Louis C. Loewenstein, instructor mechanical and marine engineering, Lehigh University, South Bethlehem, Pa.; Asa M. Mattice, chief engineer, Allis-Chalmers Company, Milwaukee, Wis.; Charles Albert McAllister, engineer-in-chief, U. S. Revenue Cutter Service, Treasury Department, Washington, D. C.; James S. Milne, superintendent Neafie & Levy Shipbuilding Company, Philadelphia, Pa.; Charles D. Mower, associate editor *The Rudder*, 9 Murray street, New York; Francis B. Smith, chief engineer, Pittsburg Steamship Company, Cleveland, O.; Horace Holden Thayer, Jr., chief hull draftsman, Pusey & Jones Company, Wilmington, Del.; William Wallace Watterson, superintendent of construction, Pittsburg Steamship Company, Cleveland, O.

Promotion from Associate to Member, 2.—Joseph Wright Powell, assistant naval constructor, U. S. Navy, assistant to the superintending constructor, Works of the William Cramp & Sons' Ship and Engine Building Company, Philadelphia, Pa.; W. P. Robert, naval constructor, U. S. Navy Yard, New York.

Associates, 18.—John Lord Bliss, of John Bliss & Co., 128 Front street, New York, manufacturer of marine chronometers and nautical instruments; John Wesley Coates, machinist, U. S. Navy, U. S. S. *Denver*; Leonard Martin Cox, civil engineer, U. S. Navy, supervising engineer, steel floating dry dock, Cavite, P. I.; William Burder Ferguson, Jr., assistant naval constructor, U. S. Navy, Navy Yard, New York; Julius Augustus Furer, assistant naval constructor, U. S. Navy, Navy Yard, New York; Frank David Hall, assistant naval constructor, U. S. Navy, assistant to the superintending constructor, Cramp's Ship Yard, Philadelphia, Pa.; Sidney Morgan Henry, assistant naval constructor, U. S. Navy, Navy Yard, Mare Island, Cal.; Frank Bowne Jones, yacht agent and ship broker, 29 Broadway, New York; Martin L. Katzenstein, 114 Liberty street, New York, manager marine department International Steam Pump Company; Charles E. Littlefield, navigator, Nautical Schoolship *St. Mary's*, pier foot E. 24th street, New York; Frederick K. Lord, draftsman, 29 Broadway, New York; William McEntee, assistant naval constructor, U. S. Navy, Navy Yard, Mare Island, Cal.; George Theodore McKay, of firm of Stearns and McKay, naval architects and yacht builders, Marblehead, Mass.; John Mitchell, vessel owner, of the firm of Mitchell & Co., Rockefeller Building, Cleveland, O.; Carle Ermanus Pfister, lieutenant, Royal Italian Navy, attaché to the Italian Embassy, Washington, D. C.; Austin E. Potter, Editor *Power Boat News*; Eugene M. Richardson, vice-president, Sherwin-Williams Company, Cleveland, O.; William Rawle Shoemaker, lieutenant commander, U. S. Navy.

Juniors, 5.—Robert Earle Anderson, fourth class ship draftsman, department of construction and repair, Navy Yard, New York; John Arnhold Engerdt, inspector steam turbines, inspection and testing department, Westinghouse Machine Company, East Pittsburg, Pa.; Sidney Graves Koon, editor MARINE ENGINEERING, 17 Battery place, New York; Arthur Schultz Lewis, mechanical engineer, in charge of test room, construction and repair department, Navy Yard, New York; Daniel M. Luehrs, student in naval architecture, Massachusetts Institute of Technology.

THE PRESIDENT'S ANNUAL ADDRESS.

It is the President's duty to briefly recall to you annually the events in our country in the art of naval architecture, but during the thirteen years of the life of this Society this duty has rarely been an agreeable one, if measured by the record of commercial success in shipbuilding. Following the Spanish war, owing to the purchase of vessels by the government, and the increased traffic with Cuba, Porto Rico, Hawaii and the Philippines for one or two years, commercial progress in shipbuilding showed a tendency to measure up to the technical progress shown by the members of our Society in its proceedings. Since these years there has been a steady decline in shipbuilding, both for ocean and coast traffic, until the former has reached the vanishing point. Shipbuilding is in a satisfactory condition only on the great lakes. There the shipyards are busy, and a steady improvement is made in the economy of transportation by the development of terminal facilities and the use of larger vessels. The success of the lake shipbuilders is unqualified, and shows the results which can be obtained by intelligent application to a problem. The coast shipbuilders on the other hand have little work, and deal with a great variety of problems, and their progress is therefore subject to the handicap of diversity of work and the small quantity involved. In the past year three or more coast shipyards have gone out of business, two have sold their plants and several more are in the hands of receivers. This is a melancholy record. A few events afford us some hope for the future. During the past year the Merchant Marine Commission appointed by Congress spent some seven months in a careful investigation held throughout the seaboard and lake cities of the United States, and presented a bill to promote the national defense and to establish American ocean mail lines, which met the approval of the committees in both houses of Congress. I quote a few words from their report:

"The American shipping in the foreign trade has been for forty or fifty years the only American industry exposed directly to foreign competition that has not been protected by the government. There is no need to look beyond this one sentence for the explanation of the hard fact that this one American industry has halted and shrunk, and while all others have made prodigious increase. * * *

"The American merchant marine is essentially a floating factory which is built and maintained on the American wage rate, but there is this vital difference, that while the land factories are covered by national protection averaging almost fifty percent, these floating factories, the few that are left, work up and down the ocean without any protection whatever, save that granted to a few steam lines by the postal subventions of the law of 1891. * * *

"An adequate American ocean fleet would mean the saving to this country of $100,000,000, which now goes to build up the commercial power and naval strength of Europe and Asia."

The bill suggested wisely includes provisions intended to create and maintain a reserve of seamen for our naval forces. There have been added to the navy during the past five years large armored cruisers, and there will be added during the coming year seven or eight first class battleships and two armored cruisers, and the resulting demand for increased enlisted force in the navy has brought keenly home to our naval officers the force of the maxim that "no nation can maintain an efficient navy without a prosperous commercial marine to support it."

During the past year evidence has accumulated that there is ample field for development and extension of the coastwise steamship traffic, and it is unquestionable that this can be promoted by the careful study of naval architects to the necessities of the trade if carried on simultaneously with the improvement in terminal facilities. This tendency will no doubt be much enhanced by the encouraging efforts for the development of the marine turbine in the United States.

PAPERS AT FIRST SESSION,

THURSDAY MORNING.

SOME PROBLEMS IN FERRYBOAT PROPULSION.

BY COL. E. A. STEVENS, VICE-PRESIDENT.

ABSTRACT.

The propulsion of double-ended screw boats offers some difficult problems in screw design. The subdivision of the power shown by the indicator is very complex, and its exact distribution well-nigh impossible. Tests were made of propellers for the *Scranton* class of boats recently put into service by the D., L. & W. Railroad, and wheels of different qualities were found to give very discordant results, the second wheel placed on the *Scranton* having required an additional 20 percent of power at the designed speed of ship without any appreciable gain in backing power as compared with the first wheel. The race from the forward screw, most seriously affecting the wake at the stern, introduced an element of uncertainty as to the power absorbed by each screw. As a result efficiencies are very different from what is obtained by similar screws in ordinary ships.

DISCUSSION.

Prof. Sadler: Mr. Stevens might explain a little more the statement that the thrust deduction minus the wake gain in those boats is probably negligible in design. It seems to me that in an ordinary ferry boat with the bow propeller the thrust deduction will remain about the same as in an ordinary boat, but the wake gain will be less. I should expect that the hull efficiency in these boats would certainly not be more than 95 percent, and probably less. This is, to a certain extent, I think, borne out by the efficiency curves. All the curves of total efficiency are very low for this type of boat. That is, the ratio of e to i never gets over 45 percent. I should also like to ask if he has performed any experiments, or has noticed any torsional vibrations in the shafts of these vessels. I think there is no doubt that there will be considerable torsional vibration set up.

Mr. Du Bosque: Col. Stevens has said that it is impossible to analyze the performance of screws on ferry boats. We have been experimenting with these inclined wheels for the last eight years, and have been trying to analyze the forces to determine what size and type of wheel should be used on any particular ferry boat, and we reached conclusions and tried the wheels and have not got good results. Now it is a fact that the forward wake of a screw propeller ferry boat has a very peculiar influence on the bow of the boat. I think we will have a great deal of difficulty in finding out what it is; but it is undoubtedly a fact, as the author has demonstrated, that an inclined wheel is very superior for a ferry boat to one with a straight axis. This fact was discovered by us some eight years ago, experimentally. A considerably larger diameter is required with a curved back wheel than with one that is straight, and I think the conclusions of the paper seem to point to that too, because the No. 1 wheel on the *Scandinavia* seems to show greater efficiency than the No. 3 wheel; we find 13 knots speed is gained with a trifle less horsepower. There is one feature about this type of wheel, however, that is more important, and that is maneuvring qualities. It seems that with the wheel blades pointing backward the water has a ve.. much better chance to get to the rudder, and on all boats that we have fitted with inclined wheels the steering qualities have been immensely improved. That is a very important feature. The backing qualities are very much improved, because the wheel, being larger in diameter and more effective in pushing, exerted a backing force on the forward end of the boat in a pushing direction. I am inclined to think that the form of blade as given on the *Scandinavia* could have been very much improved, not only to increase the speed of the boat, but to increase the maneuvring qualities. We are now building those blades very wide and fairly narrow at the tips—in fact, somewhat like one of the turbine wheels described in one of the papers to be read here to-day.

We took a 9-foot wheel, with 11 feet 6 inches pitch, off the *Cincinnati*. In place of that, we put a wheel 9 feet 6 inches diameter, 12 feet pitch. The revolutions were increased from 115 to 120, and the speed of the boat was increased above 1 knot. We never made a progressive trial with the new wheels, but the performance is very accurate, as we keep records of the actual time taken by every boat on every trip, and by applying a number of these we get a comparison of the speed of the boat.

Mr. Stevens: The only method I know of in which the algebraical sum of thrust deduction and wake gain could be obtained is by single screw type; so that in those which have been attempted, as the *Cincinnati*, the *Bergen* and the *Edgewater*, the hull efficiency worked out at very close to 99, somewhere over 98. When you come to the double screw condition it is practically impossible to separate the race augment from the total sum. The efficiency falls to a very low figure; but I know of no process to obviate it. I have tried a number of times to get at some process by which the thrust deduction could be estimated apart from race augment, but I have been simply floored.

As to torsional vibration, the shafts of these boats are usually much larger than would be used in ordinary practice. I think that the very fact that they have been operating now for some eighteen years practically without shaft troubles, shows that the shaft is working under very low stresses. I have never taken any such measurements as would give me any practical data on the subject, but I have never been able to trace the vibrations to an unknown cause, which I would then call torsional vibration.

The statement as to the relative diameter of the straight wheel entirely bears out my experience. As to steering, I have not had sufficient experience to state. The only boat I had knowledge of was the *Scranton*, where the steering was very satisfactory under both conditions. If anything, it is a little better with the curved wheel. In backing we find on the *Scranton* that the first wheel, the ten-foot wheel, was very sluggish in starting. This was due somewhat to the setting of the valve gear and the arrangement as to the valve, which lifted quickly and gave very little compression. The vessel with the original wheel was very sluggish in backing. The chief engineer considered it was due to the wheel's being too large. The *Scranton* No. 2 wheel was even worse in backing, although considerably smaller in diameter. The question as to tips is to a great extent a practical one. Too fine a tip will not stand up in ice conditions. However, a wider blade than that shown would probably give better results.

EXPERIMENTS WITH VENTILATING FANS AND PIPES.

BY D. W. TAYLOR, U. S. N., MEMBER OF COUNCIL.

ABSTRACT.

The experiments were undertaken for the purpose of learning more than was known about the capacities and efficiencies of fans used for ventilation purposes on United States naval vessels, and to obtain information to enable systems of ventilation to be intelligently designed. The tendency at present is to place main

reliance for ventilating living spaces upon the plenum system, which forces the air in, but exhaust systems are also fitted for special purposes. The conclusions drawn from experiments are briefly:

The angle of branches should be less than forty-five degrees. Elbows should not have a smaller radius to the center of pipe than 1½ diameters. Outlet fittings should be connected to branches by connections that gradually taper. The mains should be circular in section whenever practical. The size of branch should be determined by a consideration of the loss of head and consequent enlarged delivery. Rectangular pipes should be avoided whenever practicable.

DISCUSSION.

Mr. Linnard: Those of us who have had to design ventilating systems for ships know how much difficulty and doubt existed in the past as to the thing—any sort of designing data was accepted, and I think it may be said that these are the first public results which give experimental data and designing rules which will enable anybody familiar with laying out ventilation piping to design a system which can be relied upon to be satisfactory after its installation, a thing which has hardly been achieved heretofore; and this has been attained, as I am personally aware, after a very long and exhaustive set of experiments to which Mr. Taylor has devoted a great deal of time and attention.

Mr. Macalpine: There is one point with which I have been very strongly struck, and that is, the very low efficiency which he has found for fans, an efficiency which he states for the conditions of ship ventilation comes to about 50 percent, in some cases rising to 60 percent or more, but usually for higher pressures than allowed. This is a very different result from what is usually accepted among many who have made fan tests, and the question is of great interest where the difference comes in. Mr. Taylor relies altogether on the pitot tube, and says that he is convinced its accuracy is well established by independent investigations. That is a point on which there is a very great deal of difference of opinion.

Mr. Taylor's experiments go up to 22 pounds per square foot, which, with a square delivery, would expand at 140 feet per second. With such velocity even approximately steady flow is an impossibility, and in fact there is a proof of that in the body of the paper itself, where there was a velocity of 100 to 200 feet per second spoken of. As to the necessary assumption that the center of the stream line is brought to rest, of course that would be so where the stream line is perfectly axial. If it were one degree from being axial it would not be true. If it were five degrees it would be very far, indeed, from being true. In fact, Mr. Taylor says that in his experiments it was thought necessary to use ten or more tubes in large pipes in order to reduce to a negligible quantity the error due to the velocity of the air. That is a well known fact; and if he had given us the pressures at the different parts of the pipe, we would have found also that the pressures were very far from uniform.

Commanders Carnegie, Dinger, and Johnson also used pitot tubes as one of their modes of measuring. The nozzle experimented with was 24 inches diameter, in which twelve measurements were taken. In one case, while one of the tubes showed 6¼ inches pressure, another tube showed 7¼, or 16 percent over the lower. Now I am not taking up one of the experiments alone, nor were these pressures, these large gradients, transverse gradients, 24 inches apart. In two of the experiments we have the pitot tubes within about six inches of one another, registering ⅞-inch difference of pressure. This is not a perfectly constant feature, showing that it is not an experimental error that has been introduced; but it is so far constant as to show that it is a real fact that high and low pressures occurred at these points near one another. Now, if we have such heavy pressure gradients transverse to the tube, it naturally means that the stream lines are very much curved, that is that there is a great deal of vortex motion. The pitot tube takes no proper note of this vortex motion.

A very frequent way of testing is by delivering the air into a very large box so that the air currents, instead of being exceedingly swift, are very much reduced. There is still kinetic energy, which will register itself in the pressure gauge, but it is very much reduced, so that the pressure gauge has not a very powerful current blowing across it. A large kinetic energy is transformed into potential energy.

In a test on July 16 both methods were used. By the pitot tubes there was a calculation of 55 percent efficiency. The observations from the gauge in the box gave 69 percent, a difference of 14 percent. There have been a great many fan tests made, in which the efficiency has been believed to be considerably over 60 percent. I have seen fan results where, even with pitot tubes, it was calculated from the observations that the efficiency was as high as 70 percent. That at Trunham, which I have referred to, was 69½ percent, taken from the pressure in the box.

Mr. Clifford: The question of the method of measurement of the pressure and horsepower of air has always been a matter of much discussion, and in many cases much confusion. I am glad to note that the anemometer has been discarded and the pitot tube used. I have used a pitot tube for the measurement of velocity for several years, placing the tube at the end of the delivery pipe for the fan. I placed it so that the static pressure entirely disappeared, and the velocity pressure was the only one to be measured. That is my method of dodging a problem which the author of the paper has so satisfactorily solved, that of actually measuring the static pressure of a moving column of air.

I must also agree with Mr. Taylor as regards the efficiency of the fans. The tests that we have made show that the efficiency is about as he states. Of course, there is one thing to be considered, and that is that in the application of a fan wheel the efficiency that Mr. Taylor has given is a maximum efficiency.

Mr. Taylor: Mr. Macalpine appears to consider the efficiencies very low as compared with efficiencies which have been frequently attempted. That is all correct. I have seen fans as high as 96 percent, and I suspect some data would show efficiencies over 100 percent if you followed it out practically, but I may say that I am not the only worker in this field, and I know of one large firm which has made a large number of experiments of late with various types of fans, and one of their representatives was inclined to criticize my results as giving too high efficiencies. They have used the pitot tube and other methods too. The accuracy of the pitot tube method I believe is beyond dispute. The same question was raised several years ago in connection with hydraulic work, before another society, at which time the pitot tube was very much discredited. There are two things that you measure with this pitot tube—one is the impact pressure, and the other is the side pressure, which I have called the static pressure.

Prof. Zahn, of the Catholic University, has made a very large number of experiments with air. He has a tunnel in which he soaks the air. He can stop up the end of that tunnel and produce a slight amount of vacuum in it. He has made a very small opening in the end and has taken the pitot tube and placed it first outside. Keeping it in the center of the jet, he moves the pitot tube gradually in until it comes entirely in the tunnel. The head is unchanged; that is to say, the impact of the air, the velocity of the air due to the head. The air is brought entirely to rest in front of the tube and the head remains constant.

The side opening has been the real difficulty with pitot tubes. Take a pipe with one end closed. If you make a small hole in the side you will get aspiration across it. It is entirely unreasonable to suppose that the pressure in a moving stream of air could be accurately transmitted to the inside of a pipe like that. There is a small opening of that kind, where you will find that the tube I use has on each side quite a long, narrow slit, parallel to the direction of the moving air, and I think it is obvious in principle that that is much more apt to convey the pressure.

There is a further experiment which has been made by Prof. Zahn with a tube. He has taken a pitot tube of this kind and determined simultaneously the velocity by the pitot tube and by the independent method, and the results vary very little. It is true that there are differences of velocity over the pipe section, but the original apparatus had separate manometers measuring the impact pressure and the side pressure from each separate tube. There was a varying velocity, over a section of the pipe, an erratic velocity. It was usually highest in the center, but at times it would be found a little to one side. These variations may have been perhaps 10 percent. The tubes were not placed at the immediate outlet of the fan, but a little distance down the pipe, where the extreme turbulence with which air leaves the caisson had had a chance to somewhat subside.

The trouble with blowing air into a box is that air enters the box with a certain amount of kinetic velocity and thereafter carries with it a certain amount of kinetic energy, and it is very uncertain how much of that kinetic energy is transformed into pressure. Mr. Macalpine says much of the velocity is transformed into kinetic energy, but there is no way of finding out how much that is, and when you are attempting to obtain accurate results it is necessary, I think, to use apparatus and methods which will approximate theoretically to the result.

Mr. Clifford performs an experiment with a restricted delivery. That is a very good test to find out certain things. You find out what the fan does through a contracting nozzle, but you gain very little information as to what the fan will do when discharging into a full-sized pipe. We tested some fans with the restricted delivery method, and gave very satisfying results. They were electric fans. The fans were put aboard ship, and owing to the resistance of the actual piping being a good deal less than that of the conical appliance, they delivered a great deal more air. They all performed more than the manufacturer expected, but they used so much power in delivering the air that they destroyed the motors.

The question of a slightly increased first cost in a thing like this is comparatively a minor one. As fitted aboard ship, our friends in one test delivered 1½ cubic feet of air per minute per watt. The best results for combined efficiency were under 30 percent.

The President: In closing this discussion the Chair might state that these experiments were undertaken for the practical object of enabling the design of a ventilation system to be made with reasonable certainty, and to avoid complaints which were coming in from chief engineers and surgeons that the ship was full of pipes but there was no air. A conversation such as this took place: Mr. Taylor said that a number of fans had been received at the model basin, and he wanted to know what they were there for. He was told that they were there for him to find out what they could do. The paper before you is the result of three years of scrupulous scientific investigation, and fully justifies the labor and expense which has been put upon it.

PAPERS AT SECOND SESSION,

THURSDAY AFTERNOON.

EXPERIMENTAL RESEARCHES ON THE PERFORMANCE OF SCREW PROPELLERS.

BY W. F. DURAND, MEMBER OF COUNCIL.

ABSTRACT.

The present report covers in effect the performances of forty-nine model propellers distributed over the field of pitch and area ratios, from pitch ratio 0.9 to 2.1, and from area ratio 0.18 to 0.72 respectively. The experiments were carried out in the canal of the hydraulic laboratory at Cornell University. This canal or tank is about 340 feet in length by 16 feet in width and 10 feet in depth. The canal is provided with water from the reservoir above, through double shut-off gates and an intermediate lock or measuring chamber. Once filled the water is quiescent, and the level may be maintained where desired by an adjustable weir at the western end.

The curves showing values of T and Q on s, the values being reduced to standard revolutions per minute, are lines nearly straight, or curved slightly concave to the axis of slip. This general character of the relation between Q and s or T and s is distinctively characteristic of the propeller, and has been indicated by all previous experiments carried out in detail, and covering the determination of the data in such form as to bring out this relation. There is, of course, no reason for assuming that such law is naturally linear, or that there is any natural reason for expecting a straight line relation between these quantities. The general trend of the curves, as shown, indicates clearly, however, a somewhat slower increase of T and Q with s than the exact linear law would require.

The general efficiency relations indicate for a low slip, such as ten percent, a general increase of efficiency with area, except for the lowest pitch ratios, when such increase is followed by a decrease for the highest areas. For higher values of the pitch ratio and low slip, however, there is, as a rule, first a marked and then a slow increase of efficiency with increase in area, the best results being given for area ratios of thirty-five to forty-five. On the other hand, for high values of the slip, such as forty percent, there is, as a rule, a continuous though perhaps slow decrease of efficiency with increase of area throughout the range. Intermediate between these extremes we find for moderate or average values of the slip between twenty and thirty percent but slight change of efficiency with area. For the lowest pitch ratio, however, the decrease of efficiency with area for these intermediate values of the slip is still well marked.

THE DISCUSSIONS ON PAPERS III. AND IV. WERE MADE TOGETHER.

SOME RESULTS OF TESTS OF MODEL PROPELLERS.

BY A. V. CURTIS AND L. F. HEWINS, JUNIOR MEMBERS.

ABSTRACT.

The investigations were carried on under the direction of Naval Constructor D. W. Taylor, and are supplementary to those described by him in the Transactions for 1904. These experiments were carried on with two-, four-, and six-bladed propellers, there being nine of the two-bladed, twenty-four of the four-bladed, and eight six-bladed, as well as two special three-bladed propellers. All were sixteen inches in diameter and of uniform pitch, except for the two special propellers, and the pitch ratios were 0.4, 0.6, 0.8, 1, 1.2, and 1.5, as was the case last year. Very interesting curves were obtained, particularly in connection with contours.

DISCUSSION.

Mr. Macalpine: The accumulation of propeller data is excessively interesting and important; but with a model propeller and a full-sized propeller at corresponding speeds, the pressures per square inch on the surface of the model propeller are very much lighter than on the full-sized propeller, and consequently while the full-sized propeller may have such a pressure that cavitation is about to set up, the model propeller will be very much removed from that. That is to say, the action on the water will be very much more nearly uniform in the case of the model propeller than on the full-sized propeller, and consequently, since the government is at the back of the experiments, I would again suggest that they be supplemented by propellers on actual ships, and that there ought to be new and properly made trials to open up the subject. That is very important, because at the limited pressures that we have to work at in many cases nowadays we cannot be quite sure of making the steps from the model experiment to the full-sized experiment without such a guide.

These model experiments give an efficiency ranging up sometimes as high as 80 percent. I have no doubt the efficiency is due to the fact that the model blades are only about half as thick as a full-sized propeller with heavy pressure. By making the blades of the ordinary proportions, the efficiency would probably fall to 69 or 70 percent as a maximum. I should judge that Mr. Taylor probably now ascribes some considerable influence to the thickness of the blade.

In this paper we have an eye to two series of experiments with model propellers; of the thin type and also of those that are reduced from the natural propeller. For instance, Nos. 19 and 76 are compared. In the thin blade there was an efficiency obtained of 73 percent. In the corresponding thick blade the efficiency fell to 60 percent. In the case of propellers 24 and 81 the efficiency fell from 75 percent to 61 percent; that is to say, it came down in one case 13 percent, and in the other case it came down 14 percent. Now the interesting confirmation is given that the efficiency was largely influenced by the thickness of the blade, for propeller 81 was planed off on the back toward the edge, so as to get the sharper angle on the back, to a pitch of 30 percent less than that of the face.

The forms of the curves for the very thin blades and for the thick blades were very different, indeed. That is to say, the maximum efficiency not only fell, but it was obtained at a very different slip in the two cases. In the case of No. 19 the 73 percent efficiency was obtained at 14 percent slip, and in the case of No. 76, 60 percent efficiency was obtained at 32 percent slip, so that the curves were very different in form. We have the thin blade giving 75 percent efficiency at 13 percent slip, and the corresponding thick blade giving 61 percent efficiency at 20 percent slip. Now I think it would be exceedingly useful if the experiments were to be continued in the model basin to investigate very fully the influence of the shape of the section, and the thickness.

Mr. Stevens: I plotted out the curves of efficiency for two propellers tried in the model tank that were reproductions of actual propellers—that is to say, No. 76 and No. 81, both the original and modified, and compared them with the curves of the propellers of the *Scandinavia, Edgewater* and *Scranton.* The latter sections are all sections of ferry boat wheels, and decidedly heavier than are met with in ordinary practice. Of the six curves thus obtained, five ran in a fairly parallel strip from 12 percent slip up to 40. One curve, the No. 76 propeller, with a peculiar fish-shaped section, does not reach the bunch of the other curves until it gets up to a slip of about 30 percent. The other curves all have a very decided efficiency at zero slip. The maximum efficiency reached by any of these wheels was by that of the *Scandinavia* at 18 percent slip. One went up to 66.5 percent. The lowest is in the *Edgewater,* also at 18 percent slip, which is 59 percent, those being the maximum efficiencies for both of those wheels. In other words, in these wheels—they are all of them of rather fine pitch, very full area ratio and thick blade sections—the efficiency varies from a maximum of 66.5 percent down to, at working point, somewhere about 55 percent, through the practical range of the slips, which is not very far from figures which one would usually expect to find for propellers of that kind. Personally I have used on wheels of that sort generally from 58 to 62 for the efficiency.

For wheels of an area ratio of .295 and a pitch ratio of 1, I found that taking a four-blade wheel as a standard, at 100 percent, a three-blade wheel will absorb 81 percent; two-blade, 77 percent; and taking an area ratio of .4025, with the same pitch ratio, 1, and taking a four-blade wheel again as 100 percent, the three-blade wheel absorbed 76 percent, or practically the same as in the other case; and the six-blade wheel absorbs 124 percent.

THE CRUISER.

BY COMMANDER WM. HOVGAARD, ROYAL DANISH NAVY, MEMBER.

ABSTRACT.

This discussion may be considered a continuation of the author's paper, "The Sea-Going Battleship," presented last year. Perhaps the most important experience learned from the great naval battle of the Sea of Japan is that long-range fighting is possible to an extent not heretofore anticipated, a direct consequence of which is an enhanced value of heavy guns as compared with guns of somewhat heavy or medium calibers. Another consequence of long-range fighting is that the assumed average fighting distance on which armor protection should be based may be chosen greater than before, and that consequently armor thicknesses may be somewhat reduced. Assuming an average range of 4,500 yards as compared with 3,500 last year, a battleship may be permitted a reduction in armor thickness of about one inch. However, as ships were in several instances struck below the armor belt, the weight saved should be partly used to extend the depth of side armor.

In passing from the battleship to the cruiser, the general principles will apply with but few modifications; the design should in every respect be based on probable average conditions. The large ship may be made superior to the smaller in speed, gun power, and protection; and is inherently superior in nautical qualities, economy of propulsion, watertight subdivisions, and relation of sea speed to trial speed. The armor protection should correspond with the battery; that is, it should be such as to enable the cruiser to maintain a long-continued fight with an equally powerful antagonist under average conditions. The armor protection should be proportionate to the relative importance of the part to be protected; the protection of the ship should take precedence over that of the guns; the armor weight should be applied chiefly to the sides, no more weight being given to the armor deck than necessary for its functions as a splinter deck.

It is concluded that although the first-class armored cruiser of to-day is a vast improvement on what it was a few years ago, it is only partially suited for the duties which it may be called upon to perform, and cannot be considered a fully satisfactory type. It is, therefore, concluded that for all strictly military service a new and more powerful type—the battleship cruiser—should be substituted.

For a country like the United States, which has little ocean commerce to protect and to whom commerce destroying is not likely to appeal, it appears that the shipbuilding policy should be directed exclusively toward purely military objects. A few types appear to be sufficient for all strictly military duties: battleship cruisers of the same military strength as battleships but of higher speed (20,000 tons, 21 knots); scouts of extreme speed, great endurance, perfect sea-going capacity, and light armament (5,000 tons, 25 knots); small cruisers of moderately high speed, fair endurance, relatively powerful armament and protection (3,000 tons, 20 knots). The two first types are required only in small numbers, the last in greater number.

DISCUSSION.

Mr. Spear: There is one aspect of this paper that I find it very difficult to follow, and that is the line of reasoning by which the author arrives at the conclusion that the ship for doing scout duty should have a displacement of 5,000 tons. He says in the body of the paper that the number of units is not so important to the scout as the individual ability of the ship. That seems to me entirely wrong reasoning. While the development of wireless telegraphy has extended the usefulness of each individual scout, we have not discovered any way of finding the other fellow by wireless telegraphy, and the amount of scouting which you can get out of a certain sum depends upon the number of ships you can put out to scout. We have in the present large destroyers the basis of the proper scout. The ships which we call 420-ton ships are, as a matter of fact, when we go to sea, 600 to 620 tons. They have pretty well demonstrated that they can take care of themselves under all circumstances on the sea, and that they can maintain a sea speed under all reasonable circumstances which is quite sufficient for practical purposes, or at least near enough so that a displacement of about 1,000 tons can serve every possible purpose that the scout can serve. But the basis of it all is the number of ships you can get to do a certain duty for a certain amount of money. The thing that limits the scout is that it can see only just so far, and a 100-ton ship can see just as far as a 1,000-ton ship.

Mr. Taylor: The author has gone into the matter of deck armor vs. side armor with great accuracy and thoroughness, and considered it mathematically in the appendix, and finally come to the conclusion that armor should be given to the sides, and no more weight should be given to the armor deck than necessary to its functions. I fully agree with him in that. In our service for a number of years now we have followed as much as possible this dictum.

President Bowles: In making up one's mind as to the most efficient types of ship it is fair always to give some weight to the fact that you do not always expect to meet in large numbers the ships most recently designed, and, therefore, if any apology is needed for the existence of the *Tennessee* class of cruisers it is in this, that by the possession of superior speed they can choose their enemies, and that the chances are that with the armor protection and the guns they carry they would be able to engage a very large proportion of whatever enemies they might meet. It appears to me that the Japanese war has produced quite a change in the essential qualities of fighting vessels, and possibly we do not now and shall not for some time yet fully appreciate what those changes mean.

It would appear that the value of speed in battleships is much greater than we supposed it was. It would also appear that the value of handiness and small turning circles is not so great as we supposed it was, and I think that we have sacrificed unduly other qualities to those. In seeking for opportunities and for means of increasing the speed of battleships without undue increase in size and cost, these considerations which I have mentioned will operate somewhat.

The question of handiness also brings one to the use of the ram. If officers would be willing to give up the ram it would very much add to the possibilities of increased speed. I believe that the weight carried in the bow of the ship and the shape that is involved there in making an efficient ram, is a great detriment to high speed. It seems to me that the question to-day of speed of battleships is largely one of the production of the required amount of steam without excessive addition to weight, and that the gain in steam without increase of weight is to be attained in one of two ways, or it really reduces itself to one way by the elimination of hand-firing. That is, we must come to the use of mechanical stokers or the use of oil fuel, and to a type of boiler more nearly that called the express boiler.

The use of the steam turbine should enable us to get speeds in a battleship of reasonable cost which will absolutely eliminate the armored cruiser of to-day and produce a ship infinitely superior to any battleship now afloat. When that result is attained, and I believe it to be now attainable, there will be no excuse for an armored cruiser, unless a far greater speed can be obtained for them on reasonable cost than we now ask for. That is, we should have to have a speed of 25 knots instead of 22 in order to justify the cost of an armored cruiser that would be capable of meeting only the inferior battleships. That would be a question which could be decided only by careful study, the prospect being that that high speed would not be justified when the greater part of the services of such a vessel can be performed by very moderate-sized scouts.

Mr. See: The subject of abandoning the armored cruiser and raising the speed of the battleship has for some time been a prominent one in my mind. I, however, believe the vessel should not be a big, costly one, built on present lines, with high, towering straight sides to present a big target, but a more modest, radically different, as well as less prominent one. Superior speed, protection and gun-fire are all important in the battleship, but not necessarily attainable only by increasing the size of the present ship.

Those responsible for the type of battleship now in evidence have been unable to get rid of the sentiment about the walls of Old England or to recognize the fact that you can have too much wall, that the height of a battleship should not only be as low as the amount of freeboard demanded will permit, but also have its sides inclined where possible so as to deflect and not stop the projectile thrown against it, and that the armor should be of such a thickness and so arranged around the vital parts as to meet a projectile on the outside and not take chances by allowing it to enter. Also that the armament should consist of guns of the largest serviceable caliber, few in number, in order to do the work with a much smaller crew; and to be located in well-protected turrets, so as to inspire confidence and with it obtain better handling. And, finally, that the model of the vessel and the power installed should be equal to securing a rate of speed capable of commanding the best position.

I would, therefore, suggest instead of the present form of battleship an improved one containing the new features given above, and embodying also the salient points of the *Monitor* and *Merrimac* as a new type, combining the high speed cruiser and the sea-going battleship in one. The vessel will be of about 10,500 tons displacement, having but one deck above an armor belt 11 inches thick, from which the sides tumble home at an angle of about 40 degrees, starting at 6½ inches at bottom and tapering to a thickness of 5 inches at the upper deck. The tumble home will work out beyond the forward turret into a raised forecastle in order to obtain sufficient freeboard to maintain speed in sea way, freeboard amidships and aft to be 10 feet. The guns will be 12 inches, arranged in pairs, in one turret forward and another aft on upper deck. This deck will be 1½ inches thick, and the interior protective deck is to be abandoned except at ends, in view of the heavier armor amidships, by which arrangement weight will be saved, construction simplified and vessel strengthened. Another modification involves increasing the thickness of bottom plating and reduction of frame spacing for about one-half the length of vessel amidships, in order to increase strength and resist torpedo attacks. The plating will be 1¼ inches, except at turn of bilge, where it is to be 1 inch thick, and frames 36 inches center to center. By this rearrangement of material, whereby the amount in the neutral axis will be taken to increase sectional area of the upper and lower members, increased strength of structure will be obtained without increase of weight. Bilge keels are to be retained, but those for docking, inviting damage from the torpedo, are to be abandoned in view of stiffer bottom. Instead of a speed of 19 knots in battleships built or now building, we propose to increase it to 22, or equal to that of the armored cruiser, made possible by reduced weight of superstructure, armor, armament and by the adoption of a model well suited to attain it, together with the employment of engines and boilers of a design for obtaining from the least weight and with the least smoke or waste of fuel the highest efficiency under all conditions.

Such a vessel will surpass the large low-speed one with thick armor and heavy guns as well as that of high speed with thinner armor and lighter guns. In the first place, its height will be at least one deck less, so as to present a smaller target, with the sides above the belt sloping upward to deflect instead of stopping the projectile, and without openings to invite its introduction. Then the extra thickness of the belt will permit fighting at closer quarters, accompanied with a more destructive work on thinner armor of guns equal to those of the low-speed vessel and superior to those of the high. With the reduced number of guns there also comes the reduced complement, consequently less space required for their accommodation and supplies, together with the possession of a more compact organization, and with it higher efficiency. And last, but not least, this superior fighting machine can be obtained in less time, at very nearly one-half the cost of a vessel presenting a larger target, offering inferior protection, possessing less strength, equipped with no heavier guns, slower by more than three knots and calling not only for double the complement to fight her but also the additional expense connected with their employment. Such a vessel will present a type combining the best features of the battleship with those of the high-speed cruiser, and one superior to the battleship for all-around work, equal to the armored cruiser in speed and superior to it in fighting, one from which can be obtained the best and surest results with the least amount of money and in the shortest possible time, together with being more readily manned in view of the smaller complement of men.

Two such vessels as proposed, carrying a combined armament of eight 12-inch guns against four 12-inch and four 9.2-inch, with 11-inch belt against 9-inch, with a speed of 22 knots against 19, with a target at least 7½ feet lower, inclined instead of vertical, and a crew no greater in the aggregate, can be obtained at a cost but 6 percent greater than that of the battleship *King Edward VII*. The latest battleship is to have twelve 12-inch guns mounted in six turrets, four of which are to be broadside; which means that guns of but two can be used to form with those at each end one broadside, so that but eight guns will be available for this purpose. This vessel will no doubt cost complete, fully equipped, in the neighborhood of $9,000,000. If it is compared with the cruiser-battleship in the matter of gun-fire alone, the latter's superiority will be found to stand out more prominently, as seven ships, costing about the same amount of money as the three bigger ones, will present a broadside fire from 28 guns as against 24, or nearly 17 percent more.

It is then reasonable to assert that the cruiser-battleship will be highly efficient, be more useful and give more trouble to a foe than the bigger ones, consequently of greater value, the superior speed making it easier to govern the tactical situation as well as possible to engage an enemy in detail and secure the best position to harm the leading ships without engaging the rest of the fleet. The reduced height with thicker armor affords at like range superior protection against attack, thereby lessening the amount of injury from gun-fire. The guns being of one caliber the smaller crew can be more quickly disciplined for the work, so that better results are possible in less time. The importance of this latter condition will be more fully realized when it is borne in mind that officers as well as men have to be secured as well as trained, so that the smaller complement and simpler conditions to be faced will shorten the time required to complete the complement, as well as to obtain from it the highest efficiency —one of greatest importance in times of peace as well as war.

COMMANDER HOVGAARD: I do not object at all to the idea that large destroyers should be used as scouts, and are very suitable for doing part of what here is called scouting service, but it will always be for scouting service in a very narrow sense. If we read the remarks here made about the qualities that should be possessed by a scout, it is stated that they should possess a sea speed higher than that of the armored cruiser, with greater endurance, and the battery should be sufficiently powerful for fighting other scouts, etc.

Now all these conditions are necessary for an ocean scout. These qualities cannot be secured in a small ship; they cannot be obtained in any form. Alone, the requirement of seaworthiness and high endurance is enough to make these small ships altogether impossible, and their armament is always defective. They cannot keep anything like the speed of 3,000- or 5,000-ton scouts. They can be used only at short distances from the field of the vessel they are scouting. If it were a question of scouting duty over great distances, then such destroyers would clearly not be useful; if they were sent out several hundred miles ahead of the fleet they would be exposed to be lost. What is required is a few ships that can pierce the enemy's lines with tolerable safety, and not run away as soon as they meet a third-class cruiser or destroyer; and I think, therefore, that such large scouts with real sea-going qualities will always be required; but that design, of course, will not prevent the use of the smaller ships for scouting. Wherever the conditions are favorable for their use, on the contrary, they ought to be there used.

Mr. See's design has too low a freeboard. Ten feet is the freeboard we have had in several ships in this and other navies, and it has been proved that as soon as the speed came up to about 14 or 15 knots, ten feet freeboard was not enough. The ships were wet, the guns could not be worked; and the next type that was designed was given higher freeboard, and as soon as the speed was raised, even that was not found enough. The freeboard was then increased still more. And in this way we have, from years of experience, arrived at a type of both battleship and cruiser of some 18 to 20 feet freeboard, at a speed of 18 to 20 knots; and it may not be unlikely that we shall have to build a forecastle on those ships. But to have a ship going 22 knots with ten feet freeboard would be impossible, while the gun axis is no higher than it is in the *Indiana* or the *Kentucky* or *Kearsarge*. If you could drive the *Indiana* at 22 knots I doubt very much whether it would be possible to work the guns. It looks very tempting to obtain a great result on a small displacement, but whenever it has been attempted—and it has been attempted a great many times—it has always proved a failure, for the reason that you cannot secure the fundamental qualities of seaworthiness. If the guns cannot be worked when there is a little rough sea, all the saving in displacement and money is of no use; the ship will not be able to do anything like what is required from it. The fact that a ship has no secondary guns is undesirable. As ships are now constructed with 10-inch guns, a secondary armament is highly desirable if not absolutely necessary. I would say that if the battleship cruiser were made with only 12-inch guns, that would not be a good type as far as armament goes. But when it comes to cutting down the fundamental quality of seaworthiness of a ship, we have gone as far down in that as is possible in modern battleships, but to cut that down still more I think is practically unsafe.

Judging from other ships, I should say that with a shape like that with 23-foot draught, there would be a very short range, and not a very great maximum of stability.

COMPARISONS OF RECENT BATTLESHIPS.

BY NAVAL ARCHITECT H. G. GILLMOR, U. S. N., MEMBER.

ABSTRACT.

Including vessels to be laid down before the close of the present year, the six maritime powers of the world, Great Britain, France, United States, Germany, Italy and Japan have under construction forty-seven battleships, varying considerably in size and characteristics. From time to time, as facts regarding the vessels laid down by the several powers become known, comparisons on the basis of gun-fire, protection, speed and other features are made. That such comparative studies are of interest in the development of naval design is evidenced by their frequency and the number of systems upon which they are based; ranging as these have from what has been aptly termed "comparisons by instinct" to mathematical comparisons of considerable complication.

The purpose of the present paper is to compare from the point of view of the designer and builder, the latest battleships of each of the six powers named, regarding which reasonably accurate information is available. The vessels selected for this comparison are: Great Britain, *Lord Nelson;* France, *Démocratie;* United States, *Vermont*; Germany, *Deutschland;* Italy, *Vittorio Emanuele III;* Japan, *Katori*.

In the number and position of the large caliber guns less variation is observable among the vessels here considered than would generally have been the case with a similar comparison of vessels of the same nationalities in the past. The system of protection employed for these large caliber guns is, as well, almost uniform. They are all mounted in armored turrets or their equivalents near the ends of the vessel; with barbettes of large diameter or smaller diameter armored tubes for the protection of the turning, elevation and other gun mechanisms and the ammunition supply. In the extent of protection for the water-line, there is substantial uniformity, all of the designs providing for complete water-line belts. The thickness of the armor for these belts, however, varies considerably. In the matter of speed there is, except for the 22-knot Italian, which her designer has termed "a compromise type," greater uniformity than would have been the case generally in the past. One of the things most notable is the wide range in displacement of the vessels, rising from 12,624 tons for the Italian to 16,500 tons for the English ship. The past decade has brought a substantial increase in the displacement of battleships

for all the naval powers, and indications are not lacking that the limit in size has not yet been reached.

While a general idea of the relative naval values of the several vessels considered may be had from an examination of tables giving their chief characteristics, the differences among the vessels preclude anything like an accurate comparison from the point of view of the designer without recourse to some system. For naval purposes, the value of a vessel is determined chiefly by the battery and ammunition carried; the protection given to the guns, personnel and stability; the coal carried as affecting the time during which a vessel may operate without recoaling; and the speed. This value is independent of the displacement, although a relation between displacement and attainable naval value fixes the value of the latter for any displacement, and the excellence of a design should be judged by the nearness of its approach to this limiting condition.

On the basis adopted by the author, the relative naval values of the six ships in the order in which they were previously listed is as follows: 7,985; 6,995; 7,780; 6,235; 6,335 and 7,515. The efficiency of the design, represented in percentage of above values to design displacement, is as follows: 48.4, 47.7, 48.6, 48, 50.2 and 47.2, which shows a remarkable uniformity in results.

THE ULTIMA—A GLOBULOID NAVAL BATTERY.

BY ANSON PHELPS STOKES, ASSOCIATE MEMBER.

ABSTRACT.

Following the paper on this same subject presented last year, modifications in the design have been made, and the present vessel has a length of 270 feet; beam, 190 feet; displacement, 30,000 tons, including 2,400 tons of coal; draft, 36 feet; the indicated horsepower with natural draft is 10,000; with forced draft, 13,500. The main battery consists of two 15-inch and sixteen 12-inch guns of great length, while the secondary battery includes twenty-four 3-inch guns.

A NOTE FROM JAPAN.

BY GEORGE W. DICKIE, MEMBER.

ABSTRACT.

The main items in warship-building are to face high explosives, protection against mines, high speed in battleships, rapidity of firing guns; these are the most important material factors that bring victory in naval battles. It is believed that a strongly-armored fighting ship, having a speed that could be maintained at all times at 20 knots, would accomplish probably more than either the battleship or the armored cruiser. On this basis the author has figured out a warship having the following dimensions: length, 450 feet; beam, 75 feet; draft of water with 1,500 tons of fuel in bunkers and two-thirds of full supply of ammunition, 26 feet; displacement, 15,000 tons; battery, fourteen 10-inch guns arranged in sponsons on gun deck, and fourteen 14-pounder rifles on upper deck.

In two hostile fleets, the one which commands the highest speed in all his ships can choose the distance at which he will fight. The question of supplying fighting ships with fuel at sea will also be solved by liquid fuel. Much of the mechanism installed in warships for operating fittings that can readily be operated by hand is not only a waste of money and mechanical skill, but is positively an element of danger in time of battle.

PAPERS AT THIRD SESSION,

FRIDAY MORNING.

LONGITUDINAL BENDING MOMENTS OF CERTAIN LAKE STEAMERS.

BY W. I. BABCOCK, MEMBER OF COUNCIL.

ABSTRACT.

In the last two or three years there has been a great change in the conditions of lake business. This has been caused mainly by the great development that has taken place in the dock appliances for the unloading of bulk cargoes of iron ore. Great hydraulically or electrically-operated self-filling buckets or grabs of 5 or 10 tons' capacity dig their way into the cargo, and nearly all of it is unloaded without any hand work at all. In operating this modern power bucket in the hold it is evident that the fewer obstructions there are the better, and that the hatches should be as large and as close together as possible. Also that the ore pile should be concentrated on a small bottom area and, therefore, be deep or high. From these considerations there has been evolved a modern vessel in which the hatches are 9 feet wide, spaced 12 feet centers, the main deck beams and stanchions entirely omitted, and the tank top bent up to meet the main deck stringer in various forms, but all with the idea of forming a long hopper or trough in which the ore lies, and which presents a smooth surface everywhere to the buckets.

The strength is made up by carrying a heavy plate girder or arch across under the upper deck between each two adjacent hatches, connected to heavy plate webs running right around the ship. The waves met on the great lakes are uniformly short though they may be relatively high. The maximum size likely to be encountered is a wave 200 feet long and 20 feet high, and the calculations have been made on that basis.

A comparison of the various curves obtained indicates that under any condition of the loaded vessel, whether in still water or among waves, the sagging moment is in excess, and generally very much in excess, of the hogging moment. Considerable criticism, therefore, which has at various times been indulged in, as to the heavy bottoms of lake ships in comparison with their upper works, is shown to be largely unwarranted. This construction of the vessel has been a natural outgrowth of the conditions of the business, which require a very heavy bottom to resist the strains due to frequent grounding and touching in narrow and shallow channels, and also to support the weight of the cargo on the tank top, and which also require the upper deck hatches to be as numerous and as wide as possible to facilitate unloading. These conditions combine to make the bottom heavy and the deck light, and to, therefore, lower considerably the position of the neutral axis. It is satisfactory to know that strains which come upon the ship in deep water among waves are very well met by the same construction; for the compression on the upper deck is always much more severe than the tension, and to resist this compression it is comparatively easy to stiffen the stringer by one or more lines of intercostals between the beams.

DISCUSSION.

Professor Sadler: Mr. Babcock has raised some very interesting points with reference to lake steamers. What most struck me was the ratio of the length to the depth of these vessels. In the case of the *Gary* 17.7, and of the *Victory* 16 only. This, of course, is the outcome of the difficulties to be encountered, the limited draft which these vessels can be allowed owing to the shallowness of the straits and the difficulties of the service. He mentioned a wave 200 feet long and 20 feet high as about the most severe wave these vessels are likely to meet. I do not know if any definite measurements of these lengths and heights of waves have been made, but it seems to me that that wave is a little too short and steep.

The maximum bending moment as developed in this condition is naturally, as one would expect, rather low, the factor one-seventy-seventh being about one-half or one-third of what might be expected for ordinary sea-going vessels of the same size. It is very interesting to see that Mr. Babcock has added a set of curves for the bending moment for the deep-sea conditions, so we can get direct comparisons. I may say that I have a similar set of calculations under way for different heights of waves, and shall be pleased to submit them at a later period.

Another point that is raised in this paper is the question of the regulations of loading of the lake vessels. That is a question that has come up recently and I think Mr. Babcock hits the nail on the head when he says that it is the usage of carrying the greater portion of the ballast at the stern, leaving the bow light, and with reference to the carrying the greater portion of the load in the middle of the vessel. This is good practice, but leaving the light condition forward is not to be countenanced. That this is done with the lake vessels shows, I think, that an intelligent set of rules for loading as well as unloading would be an advantage to the shippers. There might be some objection to that on the part of ship owners, but no doubt they would come to that if this legislation were intelligently made.

There is another point which I think might be investigated, and that is the strain upon these vessels in the inclined condition. These vessels, as is generally known, roll rather heavily, and I think it will be found that in the inclined position the strains are more severe than in the upright. I would like to ask Mr. Babcock if he would later on give the actual stress that came upon the sheer strake and keel for these vessels.

COMMANDER HOVGAARD: I think that it would add considerably to the interest of the paper if Mr. Babcock would give us the maximum stress in addition to the bending moment. Of course the bending moment may be very interesting in ships which are so alike, so similar, but when we come to comparing ships of different construction and different bending moments it does not give us a means of comparison.

MR. COX: The vessels for the lakes are different from anything in the world, because of the restrictions as to length and draft. For that reason I consider that the addendum to the paper, which shows that if these vessels were used on the Atlantic, where they were liable to meet waves of increased length, he has assumed that the stress produced, particularly the tensile stress, would be four times that which is met with at the lakes, probably shows why it is these vessels have been built. As with the other speakers it occurred to me that the matter of maximum stress would be very important, and I hope that Mr. Babcock will be kind enough to give that in some of these vessels.

MR. DICKIE: I have been wondering for a long while why these lake ships were not built with a "U" shaped hold in the center and hatches hung on the sides so as to fold up. From the conditions I have thought all the time that the reason it was not done was because the means they had of handling the cargo were sufficiently good, and the difference between the cost of handling the cargo in the present way and with the "U" shaped hold was not enough to pay to make any changes.

With reference to the stress on these ships, I do not think myself that this actual stress would be of such value as others seem to think. If they established that point, any good indicator would give the actual stress on the ship, and while the coefficient would be of value, it would not be of great value without the actual stress added to it.

MR. LUKERS: The stress is one of the means of comparison. No doubt the theoretical or calculated stress would differ from the actual stress, still that would form a better kind of comparison than would the bending moment. By this calculated stress we have a means of comparison, and it should never be looked upon as useless. We know of vessels running across the Atlantic Ocean, in constant use, with a stress of nine tons, which are secure, and we therefore are pretty safe in designing new vessels for a stress of nine tons. So far as comparisons go this is a basis to start with, if we make our calculations all in the same way. A great many calculations have been made as to Atlantic steamers, while the lake steamers have hardly been touched. I think the question of stress would be interesting to us.

I would like to know whether under special conditions the ships show any buckling in places that have to be straightened out, or if there is a tearing. Some years ago one of the lake steamers was lost, and it was stated at the time that it was due to tearing that produced a break. Perhaps the information with which Mr. Babcock is supplied may enable him to tell us which is the probable or possible cause: whether the sagging moment produced or caused a buckle or break in that way.

MR. MCRAE: I have had some experience in these calculations, and a short time ago I was asked by some authorities in this city to make these calculations for an oil steamer of the usual depth and 450 feet long. This was a case wherein they wanted to put the machinery amidship, and the question was which was the strongest ship. I went through all these long calculations for this particular ship, and found that with the engines amidship and central bulkheads cut was the strongest, and also that the maximum stress on each ship was in the sagging condition; in this vessel it was 144,000 foot-tons bending moment and gave a maximum stress for engines amidships of 13 tons; with engines aft it was 18. This was taking waves at the length of the ship and twenty feet or under that in height. Of course, we all know such conditions as that would hardly occur in running a vessel, because a captain meeting such waves does not run over them.

MR. THAYER: Mr. Babcock has incidentally stated the fact that the stresses on salt water are some four times as great as on fresh water. To us on the Pacific coast have come a number of lake vessels, and we have probably had some as decided failures of them as have been anywhere. The lakes build cheap ships, and we are all the time thrown up against lake competition. They want to send us their ships at their prices. Their prices cannot be met on the Pacific. For their quality of ships they could be, but that quality does not suit the demand. Another point in connection with these lake ships is the position of the weights shown in this paper. As everybody knows, it is the practice to carry a load to a port and leave with a load. The Pacific coast service is decidedly against that practice unfortunately. Most of our cargoes come down the coast from the north, and ships must go up against heavy northeast winds and long seas, which have in many cases resulted in very serious damage to our ships.

Three ships came to the coast on a yearly charter. The first came with eight hundred tons of ballast, for that kind of service, and soon had her forward end beaten in by the seas. Repairs were made, and she started again, and in another month or two she had the same result, so to finish out the year's charter she had to carry a thousand tons of rock ballast. Another ship that came to us is in the service there at the present day, and has been there for five or six years. When she arrived she had about eight or nine hundred tons of ballast. That was not sufficient, and they eventually put into her a deep tank of 950 tons, and made a success of her. But the lake vessels that have come to us have always failed to meet the conditions of the coast, and I would like to see the fact worked out and placed properly before the ship people, the difference between the salt water and the fresh water practice. I run up against people who have had experience on the lakes, and they will assert that the same conditions obtain there as on salt water, but facts show it is different.

The lake vessels that have come to us have failed on account of the light weight for the forward end of the ships, and the excessive weights aft. They have not sufficient ballast to go up against the head seas, and on the coast that is one of the important things, because of the lack of cargo going north. Generally the trouble has been in the bottom. The conditions of the Pacific coast are such, in the trade that I have mentioned, with freight down, and going up in ballast, that it is very hard to build a ship suitable for the trade. These ships come to us with eight hundred tons of water ballast, which is not sufficient, and we have to increase that to practically one-third of the cargo capacity.

MR. CRAIG: The gentleman has made the statement that they were cheap ships. I would like to know whether they were cheaply built, or good ships at cheap prices.

MR. STRATTON: The *Mackinaw* and the *Kebinor* were the first two ships that were ever built on the lakes and brought to the Atlantic. They were built according to the rules of the American Bureau of Shipping, and built under my personal supervision. the *Mackinaw* was the first to come down. She was brought to Montreal in two sections. She went into service at Montreal and did service between there and Rio Janeiro, and between here and the Pacific. It is generally known that the *Kebinor* went out of existence in a collision with another ship, and the debris from each of them was afterward picked up. The *Mackinaw,* the sister of the *Kebinor,* is there to-day.

Mr. Fair: One of these ships had a dent in her stern that was made with her own bow. The ship was taken down in two pieces, and when she got to Montreal the stern rammed the bow.

Mr. Reid: A few years ago the modern power buckets were invented, and from the necessity thus created has been evolved the modern vessel, and vessels of that pattern, of which a large number have jumped into existence within the last three or four years. I would like to show you some elements of their early revolution and changes. Some years ago an English friend of mine who had great trouble with the style of vessels then in use wished to evolve a steamer very similar to what you have on the lakes. They wanted to operate such vessels, and wished to design special discharging facilities. The tank was to be formed both fore and aft, and the wing space should be preserved for the water ballast. The ships were to be built entirely for ore carriers. That was away back in 1898, and when I was coming out to the lakes in 1899, they asked me to look around here and report to them on the subject. I saw the Hulett working, or rather it was broken down. The bucket got round one of the deck beams and tried to lift it out. I was told, and reported to my people, that the Hulett was to be the pattern for the lakes, as new ships would be required. I told them it would answer very well, and in order to get more room they could cut into the excessive wing space. My friends thought it would not be a bad idea to design a ship in this way, and they got up a design. That was in 1901. Some three years later that same idea seems to have struck the American shipbuilders. But that did not do very well because the power buckets struck the sides of the hopper and damaged the vessel. And after they decided it would be best to broaden the bottom of the hopper. And it was found that you could get just as good results, and get the use of much water ballast. The ship could be built that way, with the ore in one bulk amidships, and then the ore buckets would have enough space, and we could take out the beams and have the hopper open from end to end. I think after a while the builders will come to the conclusion to adopt this plan.

Mr. Babcock: The curve of weight for the original ship is made from data obtained from captains of ships, and they put so much ore in each hatch. For instance, there are in a little more than half the hatches a certain number of car loads, say twenty cars or twenty-two cars. Of course, the ore has to be loaded to bring it to even keel practically. As a matter of fact, they leave Lake Superior a little bit down at the stern because as the coal is burned the stern gets lighter and they want to come into the receiving port on an even keel. Now it was found that the same number of cars were put in every hatch except the forward hatch, right straight through the ship, twenty cars to the first hatch and twenty-five cars to the second hatch. There is not very much difference, it is a matter of a few pounds in each hatch.

Several gentlemen have spoken of an addition to the paper in the shape of exact calculations of stress. The midship-section as given is practically all the information in the paper to make such calculations possible, and I would be very glad to turn it over to anybody that cares to go into it. The title of this paper you will observe is "Longitudinal Bending Moments of Certain Lake Steamers"; not stress. Anybody that wants to go into the actual stress or bending moments in any inclined position of the ship is at perfect liberty to start.

In lake ships, of course, the proportion of the depth to the length is very small. That is a very necessary result from the conditions of the lakes. The present loading docks, from which the ore is spouted into the ships, are only a certain height. If the top of a ship that comes to that dock is higher than the chutes, the water ballast has to be run in to get her down so that the spouts can be lowered into the holds, and the ore run in from these cars above. You have then to pump the water out, and if you have put in a great deal of water it takes a great deal of time to pump it out, even with the very large pumping facilities which are provided on lake ships. Experience has shown that without any question the ships are deep enough. Of course as the channels of the lakes are deepened so that boats can load deeper they can be made deeper.

I have never had the fortune, or misfortune, to be out on the lakes in a heavy storm; but I have talked to many people who have, and asked their opinion of the size of the waves. The greatest length that I have ever heard of was 150 feet, and I added 50 feet to that in order to make sure to get as big a wave as ever would be met. I do not know any accurate measurements that have ever been made.

Mr. Dickie's idea that lake vessels could be built with one hatch in them, and hatch covers that would fold into the center, is not practical at all. When the shutters were swung up on the inside part of the ship you could not load any way; they would come against the ore spouts of the docks. If he can get up any better hatch that can be used on the lakes there is a tremendous field for him there. Many people have been working on that for a great many years. The telescope hatch seems to be the best thing, and there are a great many objections to that.

I do not think I have ever heard of any indications of great stress by the bending of the sheer stringers. I have known it to be shown by the upper-deck stringers in the old method of stringers, say four feet apart and perhaps not stiffened; when the vessel was loaded it would show perhaps $\frac{5}{8}$ or $\frac{3}{4}$ of an inch, but I never heard of any failure of that kind; it would bend simply down between the beams. The modern practice is to stiffen the stringers by intercostals between the beams, and modern ships do not show anything of that kind at all.

As far as I can understand, the failure of lake ships on the Pacific coast has been shown forward, because of the fact of their going up light against heavy seas, and the bow has been smashed in by the sea. I have heard of that before, and I have no doubt that is what happened. I do not think lake ships have been the only ships that have shown trouble of that sort. I would like to say further that very likely the builders of the ships which have shown that trouble are not responsible in the slightest degree. The shipbuilder has to build a ship according to specifications given him, and if the owner does not know the conditions, and does not instruct the shipbuilder, the builder is not responsible. The shipbuilder is bound to build a ship as instructed, and if there are special reasons why a ship should be strengthened in special parts, he should be so told.

SOME NOTES ON STEAM-BOILER TROUBLES.

BY HORACE SEE, MEMBER OF COUNCIL.

ABSTRACT.

This paper is presented in the belief that it shows how some of the troubles of the steam boiler can be traced directly to bad design, and points out the characteristics found responsible for their occurrence. Some of the lessons believed to be taught are as follows: Restrictive circulation, whether partial or complete, will lead to the destruction of the parts coming under its influence in proportion to the degree of severity and length of time of its continuance. The margins of water lanes in the steam boiler alternately contracted and expanded at the narrowest points will be worn away in proportion to the strength and volume of the stream moving through them. Pockets permitting sediment to be deposited will lead to destruction. The life of a tube may be increased by galvanizing its surface.

DISCUSSION.

Mr. Reid: It would be interesting if Mr. See could tell us about the accumulation of scale on galvanized steel tubes; whether there is as much accumulation as in the ordinary tubes of iron.

Mr. DuBosque: Mr. See has laid down here certain rules that should be observed in designing power boilers. I do not suppose there is anybody connected with boilers who does not know these things. What we should like to know is how to accomplish them. The boilers referred to in this paper are obsolete, and the methods of caring for them are of only relative importance to us. But we are all familiar with Scotch boilers, recognized as good boilers; yet I venture the assertion that hardly any designer of Scotch boilers is fully convinced how near the last flue should be to the top of the boiler. We repeatedly have boilers designed by eminent boiler makers, in which the flanges come down to the furnace, no matter how great is the care. I want to speak of one case of the effect of superheated steam on the metal of Yarrow boilers. Superheated steam affects the shell; why should it not affect the tubes? I think if the cause lies in any direction it is in the sulphur in the gas on the exterior of the drum. The result is clearly shown in the tops by the wasting away of the metal. I think it is a mistake that the drum of the Yarrow boiler, being affected inside by the superheated steam, should be subjected on the outside to the sulphur gas liberated from the coal.

Mr. See: I have found that the smooth galvanized surface appears to shed the scale more readily than the surface of tubes not so protected. In fact, in this particular case, the unprotected tube was being roughened by the adhesion of scale and the galvanized one was not.

In relation to furnaces and high-pressure boilers, some years ago one of the boilers of the ferry boats gave trouble. There was quite an argument on the cause, which was claimed to be due to improper furnaces and everything else. Some poor fellow advanced the theory that it was grease, and they sat down on him. Where furnaces come down it is almost invariably from grease. In a case of the furnace coming down in a tugboat, they had a boiler with flat sides and round bottom, known as a Kidney boiler. The furnaces were connected with sockets, and had irons going around underneath. When that furnace came down a locomotive inspector got hold of it and said it was on account of the lack of support. I advised the gentleman interested that if the furnace came down again he had better obtain permission to come under reduced pressure and have repairs done at the works. Three extra pounds were put on and the furnace came down again, and then we found evidences of grease. But we never find powder after it has exploded, and after grease has been burned we do not find the grease. I sent an inspector to the vessel at Philadelphia to examine it and report what was necessary to be done. We put in a new furnace and fired up, and the inspector came and said: "You see we have on this pressure and nothing has happened. If that comes down again I will take your license away from you." It did not come down again. Attention was paid to keeping the grease out of the boilers. In the early days people used grease in unlimited quantities, and it did a great deal of damage. I have known cylinders where the joints between the parts were eaten away with tallow.

With reference to vertical water tube boilers and vertical tanks, it is difficult to tell just what the water level may be, and if the water comes down there is a possibility of the steam remaining in contact, and when it becomes of a sufficiently high temperature the metal will be affected so that the pressure will change the shape. That is one thing that should be avoided, and it is the general practice to protect that surface, so that the gas will pass outside and not touch the metal.

NOTES ON THE STRENGTH OF WATER-TIGHT BULKHEADS FOR BATTLESHIPS AND CRUISERS.

BY HAROLD F. NORTON, ASSOCIATE.

ABSTRACT.

In the latest ships the requirements of the Navy Department are that all bulkheads below the protective deck shall be tested by filling the compartment on one side of the bulkhead with water under a head of 35 feet above the bottom of the keel. Bulkheads so tested must stand the pressure without appreciable permanent set, or deflection sufficient to cause serious leakage or to endanger the collapse of the member tested. The amount of leakage tolerated being so slight, the deflection of the plating at any point must be held down sufficiently to prevent any danger of breaking the calking.

Usually the stiffeners are vertical, equally spaced, and bracketed at the heads and heels. Since the plating cannot be depended upon to act as a tie, we must assume that the whole load of water pressure on a strip of plating of width equal to distance between stiffeners is carried by one stiffener. In supporting this load, it is reasonable to suppose that the stiffener conforms to the laws of flexure, and acts as a beam fixed at the ends.

The formulæ for the behavior of a beam of uniform section, so loaded, are not treated in the ordinary books on the flexure of beams, but were derived by the author for use in the discussion of the action of a certain bulkhead. These formulæ are, however, rather cumbersome for practical use, and it is the object of this paper to present certain curves derived from them, and from which the required results may be immediately obtained.

DISCUSSION.

Commander Hovgaard: It appears to me doubtful whether we are justified in considering the double stiffeners used in the United States ships as fixed at the ends. Mr. Norton pointed out the discrepancy between the deflection as determined by the formula and that actually observed in the *Illinois*, and he discussed this matter very fully. His conclusion was that by applying the factor to the calculated deflections he would obtain very nearly the observed deflections, and that the formula for a stiffener fixed at the ends could be used for finding the stresses.

By tests undertaken in several other battleships and cruisers, and which have been analyzed in a thesis work carried out by Assistant Naval Constructors Furer and McBride, it was found that the ratio between the observed and calculated maximum deflections varies considerably in different stiffeners, and that in some cases its value approaches 6. Moreover, it has been found that in the same stiffener this ratio is far from constant, but increases very rapidly toward the ends, and the measurements have in no case revealed the existence of points of inflection; if they have existed at all they must have been very close to the brackets. The curve of deflection approached in fact very closely to that for a stiffener freely supported at the ends.

The following table, which deals only with maximum deflections, and part of which was calculated in the said thesis work illustrates this point:

Name of Ship.	A Observed Net Deflections.	Calculated Deflections.		Ratio Between $\frac{A}{B}$ Deflections.
		B Stiffener Fixed at Ends.	C Stiffener Freely Supported at Ends.	
New Jersey	1.10 in.	0.19 in.	0.96 in.	5.7
Rhode Island	0.81 "	0.18 "	0.93 "	4.6
Colorado	0.83 "	0.22 "	1.14 "	3.7
Illinois	0.94 "	0.22 "	1.11 "	4.2

I speak here only of double stiffeners, as I have not had an opportunity to study the case of single stiffeners. The great discrepancy which, in spite of careful bracketing, is found between the actual results and those that might be expected is, I believe, due to the following causes: (1) Lengthwise (vertical) shearing along the neutral axis at the ends of the stiffener, causing a tendency of the stiffener on one side to move upward, on the other downward. This tendency was evidenced by the lifting and buckling of the brackets, which took place by the first test carried out on the center line bulkhead of the *Illinois*, as described in Naval

Constructor Woodward's paper in Volume 6 of the Transactions When this action occurs the double stiffeners will behave more or less like two independent single stiffeners, the bending moment at the apex of the bracket will decrease, while that at the middle will increase and with it the deflection at the middle; the points of inflection will move toward the ends.

This action should be resisted chiefly by the rivets connecting the flanges of the stiffeners through the bulkhead. But there is only one line of rivets, which passes through four thicknesses of steel plus a layer of felt. The shearing stress to which these rivets are exposed may be extremely high (for the case dealt with in the paper I found the stress 19 tons per square inch).

(2) Bodily turning of the double stiffener in a vertical plane round a point near the apex of the brackets; the stiffener behaving to some extent as a beam hinged. (3) Bending of the stiffener due to insufficient stiffness (moment of inertia). This action was exemplified in the second test of the bulkhead in the *Illinois*, described in Mr. Woodward's paper; it occurs even if the stiffener is held perfectly firmly by the brackets, and the bending is of the same nature as that of a flexible string. Such bending will be accompanied by overstraining at the apex of the brackets.

Any and all of these causes may be operative in producing the increased deflection which has been observed, depending on the construction of brackets and stiffeners in each particular case. It is probable that the action is very complex, and with our present knowledge of the subject I consider it impossible to determine to what extent each of these causes influences the final result. In spite of the close correspondence which is found between the actual deflections and those calculated by the formula for a freely supported stiffener, I would not consider it safe to use that formula any more than the one used by Mr. Norton for finding the stresses. I believe it is best to acknowledge our ignorance, and therewith, the necessity for a further minute study of the problem. Only more systematical and refined methods of testing and measurements can reveal what actually takes place in the stiffeners.

In studying the behavior of these double stiffeners we are naturally led to inquire into another question, namely, whether the material in such stiffeners is used to best advantage. I have already referred to the imperfect connection of the channels through the bulkhead, but the chief objection to this construction is the accumulation of material near the neutral axis. Not only the flanges of the channels but the bulkhead plating itself contribute very little to the moment of inertia. The liners might be avoided by using flush plating as is done in the English ships.

If we make all the stiffeners of same scantling it appears that there can be no gain in space by double stiffeners as compared with single stiffeners of same total depth. Center line bulkheads may, if single stiffeners are used, be placed a little out of the center line; on coal bunker bulkheads the stiffeners may face the bunkers, and on the transverse bulkheads between engine and boiler rooms the spaces will remain the same as with double stiffeners, if the stiffeners all face the same way.

It would, therefore, appear better to place the stiffeners wholly on one side of the bulkhead, whereby the bulkhead plating may be made to serve as one of the flanges, and may then contribute enormously to the moment of inertia. In such case the connection of the stiffener to the bulkhead should be by two flanges, each large enough to take a double line of staggered riveting, so as to prevent the plating from tearing from the stiffeners when the water pressure is applied from the side of the stiffeners. Whether single or double stiffeners are used it appears doubtful whether the perfectly uniform distribution of stiffeners now used in the United States ships is the best.

By tests of bulkheads it has been observed that the stiffeners nearest the ends of the bulkheads take a much smaller deflection than those nearer the middle, a fact which has been pointed out already by Mr. Woodward in his paper. This can be explained only by the support which the stiffeners get through the bulkhead plating from the adjacent rigid boundary. It shows that such stiffeners might without danger be lightened, and that it is possible to construct the stiffening system of a large bulkhead of a limited number of very deep main stiffeners, spaced at intervals with much lighter scantlings. This is the system used in the English Navy. It is about 25 percent lighter than the American system.

If with this system the internal arrangements permit placing the main stiffeners wholly on one side, they may for a given section modulus be constructed much lighter than the double stiffeners, since the web may be lightened by holes; the depth can without difficulty be tapered off toward the top, and the bulkhead plating comes to form an integral part of the stiffener. I believe, therefore, that in this way we may effect a considerable saving in weight.

Mr. Furer: It would be very dangerous to use this formula which Mr. Norton has produced from the curves, because they are based on beams fixed at the end, and actual experience shows they are a great deal more rigid, and, therefore, contribute much more to the bulkhead. In the case of the *New Jersey*, where beams were calculated as secured at the ends the calculated deflection coincided within fifteen percent with the actual deflection observed; while in the *Illinois*, where the upper bracket is secured to the deck rather than to girders, and, therefore, does not have as much tendency to get out of line, the difference was twenty-five percent.

Mr. Norton: The curves which have been drawn by Capt. Hovgaard do not appear to agree with the curves observed in the *Illinois*. We were convinced by the *Illinois* that the stiffeners did not need to be fixed at the ends; because of the character of the observed curves; also because the brackets came away up between, along the middle, as though they were doing their very best to fasten the beams at the ends.

In the work we have done at Newport News, the bulkheads figured in this model have set the pace. The whole idea of getting up this paper was to show what we have used in practice. We are aware that there is a question in case of a serious outside rupture about the ability of the brackets to fasten the beams at the end. A great deal may be said regarding the remarks made that it is very improper to arrange the brackets at the ends so they would hold the beams. To do that demands an arrangement to connect the brackets at the ends of the stiffeners to proper support, and then figure the stiffeners to fasten to beams fixed at the ends. As a matter of fact, that is just what will suffice to better the construction, to provide brackets all along the bottom fastened to deck brackets and to the foot of these bulkheads.

The amount of deflection observed in these bulkheads, it has always seemed to me, was to be explained by the way they are built. The stiffeners are not all of one piece, and we could not expect to rivet a number of things together without having some internal stress, which appears as soon as the pressure is put on the bulkhead, and it seems to me these internal stresses appear by their acting just like an oil can, pressing out on one side or the other as soon as pressure is put on it.

PAPERS AT FOURTH SESSION,

FRIDAY AFTERNOON.

MARINE APPLICATIONS OF THE CURTIS STEAM TURBINE.

BY CHAS. G. CURTIS.

ABSTRACT.

The first vessel to be propelled by steam turbines of this type, and the first vessel of any kind to be fitted with twin shafts and screws and twin turbines independently controllable and reversible, was the yacht *Revolution*, built in 1902. The practical operation of the turbines was in every respect most satisfactory and convincing, neither one ever having required any repairs of any

kind, and the steam consumption was shown by torsion shaft test to be substantially equivalent to that of the ordinary triple expansion engine under average working conditions. The boat, however, failed to develop the speed anticipated, and it was a long time before we could find out why this was so. Several sets of screws were built for the boat, the last set having a diameter of 4 feet and a pitch of 4 feet and having thin blades of well known form. From what is now known of the action of propellers of this character, and from the fact that the turbines did develop the power expected, we have been led to conclude that the trouble with the *Revolution* was in her model, which in the afterbody is very bad, her floor not being drawn out aft far enough. This view is confirmed by the best marine architects whom we have consulted about the matter, and who have observed the wave action of the boat, which is very excessive, even at a speed of only 18 knots, which was the best that could be obtained, though 21 was expected.

Some time ago the Fore River Shipbuilding Company entered into contracts for the construction of two large vessels to be equipped with twin independent Curtis turbines, which vessels, together with the turbines, they are now building. One of these is the United States scout cruiser *Salem*, and the other is the Southern Pacific steamer *Creole*. During the past summer the Vulcan Shipbuilding Company, of Germany, completed a turbine vessel called the *Kaiser*, which is fitted with two shafts and two independent turbines of this type. The actual figures guaranteed were a speed of 19½ knots, and a consumption during a six-hour run of not over 4,700 kgs. of coal per hour, including all auxiliaries. Progressive speed trials were had up to 20.46 knots, the propellers turning at 555 revolutions per minute. During a six-hour run 20 knots was averaged on 4,060 kgs. of coal per hour.

PAPERS XII. AND XIII. WERE DISCUSSED TOGETHER.

MARINE STEAM TURBINE DEVELOPMENT AND DESIGN.

BY E. M. SPEAKMAN, ASSOCIATE MEMBER.

ABSTRACT.

The rapid development of the marine turbine has taken place entirely in Great Britain; a few experimental vessels have been built here and in continental Europe, but nothing has yet been done commercially. Now that the proportions of turbines and propellers can be determined with ample accuracy to enable very stiff guarantees to be made, both for speed and economy, a similar development may be expected in other countries.

The most important feature in the development of marine turbines has, undoubtedly, been the decision of the Cunard Steamship Company to adopt turbines for the new vessels of that line. For some time it has been evident that new mail steamers would be required, though for many reasons the date of ordering them was postponed again and again. Among the investigations that were carried out for determining the relative efficiency of the two systems, were trials made on the turbine steamer *Queen*, and the other vessels running on the Dover-Calais service, and also on the *Brighton* and *Arundel* on the New Haven and Dieppe station. These tests were amplified by data obtained from the Clyde turbine steamers and from two large destroyers tested by the Admiralty.

While many of the advantages claimed for the turbine over piston engines are inseparable from the use of such a motor, others are largely dependent on excellence of design, and the prescience with which these claims were made in the days of the *Turbinia* and *Viper* has been fully justified in the light of later experience.

If there seems any tendency to exalt the turbine unduly, it must be dismissed from consideration; the reciprocating engine is by no means obsolete. It has played a most useful part in the world's engineering, and if it should happen that it must go before the rapid advance of the rotary engine—and for many classes of vessel it is already supplanted—it may be remembered that sails had to make way for pistons, and that while the *America's* Cup is still to be won, it is unlikely that they will disappear entirely.

DISCUSSION.

MR. KIMBALL: I wish to ask what is the minimum speed of a vessel that can be recommended for the use of turbines, and also with how small horsepower they have been found efficient? That is, how small the units can be made before the advantage of the turbine ceases to be of material interest?

MR. WHEELER: How about the application of the steam turbine for ferry trips, with the double-end screw? I remember when I took the trip on the *Revolution*, the turbine was handled very readily for backing or going forward, and I should think that the application would be quite successful for ferry-boat service.

MR. MACALPINE: Mr. Speakman's paper is excellent, so far as it goes, but in some respects it does not go quite far enough. In the last part one might complain of a great deal of indefiniteness, and being given hints where much fuller knowledge might have been forthcoming.

Mr. Speakman very properly writes as an enthusiast for the turbine. But it is very difficult to be an enthusiast and at the same time be perfectly judicious. Those who have taken a particular interest in the turbine must know that there have been considerable difficulties experienced. That cannot be otherwise—difficulties to which Mr. Speakman makes very slight reference. We have, for instance, a comparison of the *Amethyst* and the *Topaze* —a comparison which has been very frequently made since the particulars were originally published in *Engineering* last year, which seems to show that in this particular case the reciprocating engine and the turbine give equal steam consumption at about 14 knots, which, no doubt, under the conditions of the trial, was perfectly true. Last year I got from the British Admiralty the figures for the low consumption trial of the *Oak*, which was made long before the comparison of the *Amethyst* and *Topaze*, the *Oak* being run under the most favorable conditions for low consumption, with one screw and one boiler. The *Amethyst*, of course, was run with a cruising turbine in use; that is to say, she was run under the most favorable conditions possible at low speed. Laying down the curve, the consumption of the *Amethyst* and the *Oak* were equal, not at 14 knots, but at 20 knots. At 14 knots the consumption of the *Amethyst* was about 100 percent higher than that of the *Oak*. Then again the *Victorian* and *Virginian* are referred to in the paper, but I think every one who has taken care to gather information about these two ships will not be inclined to believe that they have been an enormous success. In the new Cunarders we have been very clearly given to understand that there is no hope either of saving in weight or of saving in economy. And is it not true that these Cunarders have been increased very much in size in order to allow the turbines to be used? Is it not true further that work on the large Cunarders is being made to go very slow until the *Carmania* is out?

Admiral Melville and I have concluded that the turbine could be most successfully applied—could be applied only to fast steamers; and that there was great risk, as far as the economical results were concerned, in applying them to steamers of much less than 20 knots' speed. We concluded, however, that the turbine has a very large field. The reciprocating engine, however, unless there is some further development, has a very much larger field. The enormous bulk of the business is carried on in steamers a long way below 20 knots, and in that class of boat, so far as the turbine has been developed to-day, I do not think the turbine will be a success. To gain economy with the turbine we must have very high peripheral speed, which for a moderate diameter means very high revolutions. Now, for the efficiency of the propeller we must have a very moderate speed, and the two conditions come near one another only when the speed is high.

Mr Speakman presented a paper last month before the Engineers and Shipbuilders in Scotland, which in some respects is a good deal fuller than the paper we have in our hands. It would be a very good idea if Mr. Speakman would fill up some of the gaps which, for certain reasons, he has seen fit to leave here. The details of turbine design which he has given us are very meager. The subjects of propulsive efficiency and propeller thrust are frequently referred to. The value of the propulsive efficiency is supposed to be known, or to be calculable with considerable accuracy for the various classes of work, in determining the proper dimensions of the propeller and turbine. To predict in a proposed design of a ship the value of the effective thrust within five percent, it seems to me, is practically impossible, and in the design of both the propeller and the turbine much larger errors would have to be allowed for.

If Mr. Speakman would give us the complete calculation for a particular case, both the calculations on which one could make the preliminary determination, and the exact calculations of pressures, efficiency, etc., with notes showing what is deduced from theory and what from his own experience and judgment, I think it would be very desirable. The turbine theory is much less perfect than that of the reciprocating engine, and there is much more in which judgment and data from particular cases count. This calculation would compress a large amount of information into a concise and handy form.

There is a great deal of data which has to do with the different sizes of circumferential clearances to allow for the warping of the port and rotor, perhaps a permanent warping due to the metal changing its shape after being machined—a question which has to be very carefully considered. There are radial clearances, and there are longitudinal clearances, which should be as great as possible, so long as the efficiency does not suffer. Then there are the clearances of the balance rings, and it would be very interesting to have information as to the percentage of loss due to the steam passing those rings.

President Bowles: As to the Staten Island ferry boats, it seems to me obvious that a machine consisting of a single drum on a continuous shaft, and containing within itself a number of wheels that would operate that boat at full speed in either direction and with equal efficiency by simply shutting off the steam from one end and turning it into the other, has obvious advantages over a vessel containing two complete triple-expansion engines with a number of moving parts. It has also appeared to me that control of such an apparatus for ferry-boat work has an obvious and enormous advantage. I can conceive that within an appreciably short time it will be possible to control such a turbine engine from the pilot house, and to place it absolutely under the control of the man at the wheel.

The turbine has enormous advantages in practical use entirely apart from the exact economy that can be obtained at the present time. Whether the economy is 10 percent less or 10 percent greater than that of the triple-expansion engine will hardly weigh with the practical advantages of the turbine for marine propulsion. For merchant vessels the very substantial gain that can be obtained in carrying capacity by the use of the turbine will far outweigh any of the questions of relative economy that are being brought up with regard to the use of fuel. You may not see now how that is going to be brought about, but it will be shown.

There are a number of collateral advantages in the use of the turbine. Its readiness for operation is an important one in many commercial services. That has been shown, and the results have been published, in the generator turbines in use in the work at Niagara. The troubles which infest boilers from the excessive use of lubricants will be vastly reduced. I believe that the labor and the attendance upon these engines will also be very considerably reduced over what is now customary in our regular steamers. When we come to warship construction the turbine assumes a different aspect. In securing high speed in war vessels, which now seems to be much emphasized in its importance, the question has largely resolved itself into securing the maximum supply of steam for a given weight, and now that the introduction of the turbine permits the efficient use of all the steam that can be generated, that should very much facilitate the increase in speed in larger vessels, without corresponding increase in weight. It will permit and encourage the introduction of oil fuel as a means of producing a greater quantity of steam with the same weight of boiler. In the same way it will encourage the introduction of the mechanical stoker for the same purpose. And, I believe, that as the result of these three elements, that is, oil fuel or mechanical stoking, the water-tube boiler, and the turbine, we are about to see a radical improvement in the types of war vessels.

Mr. Forbes: The silence which fell on this community when the chair offered the paper for discussion, I think, judging by my own feelings, arose from the fact that we felt as if we were assisting at our own funerals. But it seems to me that these papers are read to give us instruction—not merely to tell us where we can go and get something; and I earnestly hope that those who have had actual experience themselves will, in the further discussion, tell us a little about the troubles that they have, and the difficulties that they encounter in handling them.

Mr. Emmet: I have had a wide experience with turbines of the Curtis type. Some four or five years ago I became convinced of the practicability of this idea from certain results obtained on a very small experimental machine, which had not appealed forcibly to others who had inspected it. Upon the strength of my conviction I committed my employers to many millions of dollars of expenditure in developments based upon that idea. The carrying out of that work involved the construction of many hundreds of turbines, and we have had a great amount of experience with the practical problems involved, and also with the problems which relate to the turbine art generally. Our work is the application of turbines to the driving of electric generators, and it is essentially a high speed problem; but in the course of our experiments and developments the possibilities with other speeds have also been developed to a very great extent; and, furthermore, the mechanical problems and the construction possibilities have been developed to a very considerable degree, and we are, therefore, in a position to form ideas concerning what can be done. The turbine problem is one which involves a vastly greater number of variables than the problem involved in the application of steam engines to similar purposes, because turbines may be built in a greater variety of ways. The problem, therefore, presents theoretical complications with great mechanical simplicity.

The Curtis turbine involves certain practical features which all other turbines, in my opinion, have lacked. In the first place, it is a machine which operates without thrust. In the second place it is a machine in which clearance is a matter rather of indifference than of practical limits; and in the third place, it is a machine which can be built in very light weights, even where the diameter is extremely large. I may say further that it is a machine in which a very small number of parts can be used, as compared with the number of parts with other types of turbines. These matters are all of great importance, because they make possible the use of very cheap, simple and light constructions. In our electrical work, which is high speed work, our constructions are necessarily very strong, and there are great strains to be dealt with. In the marine problems these strains will not exist, and, consequently, a very much less expensive type of construction can be made practicable.

In the Parsons type of turbine the thrust must be balanced, and the balancing of this thrust must involve certain loss through clearances. The amount of clearance required will govern the economy in a sense, and the losses will vary if the adjustment varies. With the Curtis turbine no such limitation exists, because thrust is absent, except such thrust as comes from the propeller; and economy is independent of the actual clearance of the buckets within such limits as we need to consider. For this reason a test of certain buckets on a small wheel is an absolute guarantee of the performance of the same or similar buckets on a large wheel. In the Curtis turbine design you have a construction which can be made strong and stiff with a very light weight, and its cost will probably prove to be comparable rather with the cost of decks and hulls than with the engines.

We have had many serious troubles with turbines through various kinds of miscalculations and misunderstandings. Our first wheels were steel disks, and some of them under certain conditions of casting strains would buckle. When we began we did not know what our clearance should be, and we had trouble with wheels touching. We have since found ways of preventing the buckling of the wheels, and have found that we can increase our clearances on large machines without affecting the steam economy. We also had trouble with the governing mechanism; and the valves stuck. All those troubles, however, have been overcome, and among our last turbines are two in Boston, 5,000 kilowatt, which have been operating for a year, and there has never been with them a minute's trouble of a mechanical character. They are doing considerably better than the steam guarantees made upon them.

To properly apply the turbine is a great problem, a problem which will require engineering skill and daring, and if anybody thinks that he can get the product ready made and apply it to a ship without having practical difficulties he deceives himself.

Mr. Dickie: The previous speaker mentioned that all the parts of the rotor were balanced before they were put together, and that that was one of the difficulties in the rotor of the Parsons turbine. I saw one of those turbines being fitted up. It was taken apart quite a number of times and filed and chipped in order to get the rotor properly balanced, so that the center of gravity was on the axis of rotation.

In the Curtis turbine, has there been any difficulty with the rocking moments set up by the pitch of the vessel on any boat that has been tried? That is, where the rotor of the turbine in revolving pitches, with a motion forward and a rotary motion producing a condition which turns the turbine on its base? This was very carefully figured out by Prof. Gray on the Parsons turbine for the new large Cunarders, and it was found that the points of support are so far apart that the actual strain is negligible.

Mr. Winship: Can the turbine engine be made of suitable size to drive auxiliaries? A large turbine uses no lubrication and no oil. If we could use the turbine for the auxiliaries it would be a very good thing. If we can get it to run at from 800 to 1,000 revolutions the auxiliaries could be operated very nicely with turbine engines.

Mr. Crane: I have had some personal experience with the only turbine-driven vessel which has been in general use about the harbor of New York, and it has brought to light some difficulties which I think would make it inadvisable to use such vessels for general harbor use. The *Tarantula* has been in general service between Twenty-third street and Great Neck for the past two years. She has three propellers driven at 1,400 revolutions. Those propellers were very efficient when they were new, but when they had been in use for perhaps two or three weeks the edges became so badly deformed, owing to striking logs and driftwood, which are very common in the East River, that they had to be removed and replaced. During the past summer we have used six sets. Now that, it seems to me, for ferry use, would be rather disadvantageous, and I venture to say that the propeller problem is the greatest difficulty of the turbine.

Mr. Mosher: I replaced the boilers in the *Tarantula* after about two years' service. The old boilers were opened up, and we found considerable quantities of black deposit, and considerable indications of corrosion, and began to search for the cause. We had some of this deposit analyzed, which brought to light the usual causes with one addition—a considerable deposit of aluminum. The only source from which that aluminum could come is the blades of the turbine, which I understand are made of aluminum bronze. The percentage of aluminum was something over seven, and I would say that the water was the ordinary East River water. That would seem to indicate that there must be considerable deterioration of the blades of the turbine. As yet there has been no physical demonstration of it, but we expect during the winter to have an opportunity to examine the blades, when we may be able to present some additional information on the subject.

Mr. Curtis: I might add that the total power capacity delivered or under order is somewhere between 600,000 and 900,000 horsepower.

In the uses of the turbine on land the advantages in the machine do not show up materially until you get into sizes of considerable horsepower. We have not had enough experience in marine work to enable us to say at all from practical experience how low down you could go in power or in boat speed and get a result that on the whole would be as good or better than an engine. With a launch of moderate or slow speed, say of 12 or 15 horsepower, I question whether there would be any material advantage in the turbine, except the great simplicity of it. There is nothing to break down; there is a complete absence of parts; and nothing to get out of order. Our opinion is that that advantage is not enough to offset the disadvantage. In large vessels it is absolutely necessary to get a propulsive economy as good as the present engine, because the men who have to pay the coal bills will not listen to anything that entails an increased expense. But it is hard to say at present exactly how the turbine proposition is going to work out as regards economy. In some cases Mr. Parsons's boats seem to show an economy over the engines, while in other cases they do not seem to be as economical as the engines. Unfortunately, the practice of measuring shaft horsepower has not been introduced, and we really cannot tell anything about it. There is one interesting aspect of the use of the turbines, particularly our turbines, and that is the possibility of doing well at cruising speeds in naval work. This turbine is so designed and built that we can maintain the pressure distribution at different stages by closing the valves, and thereby we can get just as good an economy when running at slow speed as when running at high speed, barring the circumstance that the buckets are turning slower and therefore not as efficient.

There is quite a disadvantage in that in order to be able to run in both directions and do so economically you have practically to put two turbines on every shaft. These ferry boats require large screws. They must have a large starting capacity, and a large stopping capacity, and that means that you want low revolutions, and as they are rather low-speed boats anyhow, you have to have very large turbines on each shaft. Of course the reversing turbines in the case of an ordinary vessel do not require to be economical. As a matter of fact, by using two stages to reverse compared with seven stages to go ahead, we get a reversing power on the same steam consumption which is about 60 or 70 percent of what we get going ahead, and that is all right where you are only backing or stopping—reversing momentarily for the purpose of stopping the boat—but if half the time you are running in one direction and half the time in another, it is a different proposition. I do not think that the turbine offers a good solution of the ferry-boat proposition.

The wheels of our turbine being disks in form, there is no difficulty whatever in balancing them. It is not even necessary to balance the buckets or to balance the segments before they are put on. If they are simply bolted and attached to the wheels, and the wheels, as a whole, balanced, which can easily be done, we get a balance which is practically perfect for marine uses. In higher-speed work, such as the General Electric Company use, it is necessary to get a dynamic balance in most cases. That is, the wheel has to be spun to let it find its own axis, and if that does not agree with the physical axis of the wheel, it is marked, and the balance of the wheel is changed by adding weight to it on the other side. But practically there is no trouble in balancing.

In regard to the side thrust on the bearings, due to the shifting of the bearings changing the direction of the axis, which takes place when the ship pitches, we are without experience. I should say that the gyroscopic effect certainly would not more than double the side thrust on the bearings, and that would be of no consequence. Where the weight is large the revolutions are very much reduced and the rolling or pitching of the ship is comparatively low; so that in a large ship it would not be so bad as in a small ship.

In regard to the deterioration of the propeller blades, our experience in the *Revolution,* which had somewhat smaller blades than the ordinary practice, was that we did not suffer from bending or cracking. I think twice in a year and a half the tip of one of the blades got bent a little, but we had no difficulty in straightening it when it was taken out. The boat was used around New York harbor all the time, and every now and then we would strike a log. It seems as if it would do a great deal of damage, but for some reason it does not. I should imagine that it is very easy to reach a limit in the thinness of the blade.

HOW A NINETY-FOOTER BEHAVES IN AN OCEAN RACE.

BY PAUL EVE STEVENSON.

ABSTRACT.

Through the bad weather, whether running or lying to, the sea motion of the yawl *Ailsa,* which was with one exception the smallest vessel that took part in the great race for the Kaiser's Cup in May, 1905, was the most astonishing attribute of the boat. Instead of knocking the crew about, it was found that the rolling and pitching were so pliant and comfortable as to astound those who were prepared to encounter the worst moments in their experience. As a matter of fact, the rolling and angle of heel at their utmost could not approach that of a large sailing ship either running her easting down or hove to in the Southern Ocean. The height of the largest seas was perhaps from 40 to 45 feet from crest to trough but every one of them broke heavily with a curved edge from which it was very difficult to get away, and their sides or flanks were almost vertical.

Many yachtsmen speak of the yawl rig as the very essence of everything desirable for a sea-going vessel; in their eyes it seems to have almost preternatural gifts in heavy weather; when Herculean tasks abound there is nothing to compare with it. The truth about the yawl is that the rig breaks up the sail area and reduces it for racing purposes, and that it does not seem to be of any use at sea. If the jigger were carried when laid to, the boat would go all the way around on the other tack and create incredible confusion; and in moderate weather close hauled, a cutter will outpoint and outfoot any yawl of her size ever built.

PROBLEMS IN CONNECTION WITH HIGH-SPEED LAUNCHES.

BY CLINTON H. CRANE, ASSOCIATE.

ABSTRACT.

The very recent development of the so-called "gasoline engine" of extremely light weight in proportion to its power has given the opportunity of making another step forward in the direction of great speed upon the water. Up to the present time gasoline engines of extremely light weight have been available only in powers up to 300 horsepower, and in the majority of cases of successful operation, in powers not exceeding 150 horsepower. In utilizing this new form of power the size of the boats has necessarily been small. In choosing a type of hull naval architects have had to avail themselves of what had already been done in steam.

The most serious objection to sharp bows and "tooth-pick" sterns, as they used to be called, is the loss of stability which this form involves. Apparently this loss of stability is much more serious and more noticeable at high speeds than at low. Whether this is due entirely to the increased torque of the propeller is a matter about which the writer is not yet entirely clear. This torque of the propeller in a fast single screw launch is a matter of serious consequence. In the case of the *Dixie,* running at full power, this torque amounts to placing a weight of 350 pounds at the gunwale, or about 8 percent of the boat's weight. In my opinion, for the best use we need a compromise between the extremely sharp and the extremely flat types. It is in arriving at this compromise that the naval architect can best show his skill.

DISCUSSION.

Mr. Cox: Mr. Crane said that in running the *Dixie* the rudder was a very useful factor in keeping her right side up at times, and that is a rather unusual thing. It is peculiar to think that it is possible to keep a boat right side up by the use of the rudder. Of course, this consideration is more academic than practical, but it brings up the fact that from a purely theoretical point of view the study of the stability of boats being driven as these boats are is extremely interesting. Possibly most of us were very greatly struck by the comparison of the *Napier II* and the *Dixie.* As pointed out, there was nearly 50 percent greater displacement in the *Napier II,* yet she succeeded in developing a very small fraction greater speed than the *Dixie.*

It seems to be demonstrated from the propeller experiments that have been given this year and last that the small diameter propellers are relatively more efficient than the large diameters. It seems that Mr. Crane has experienced cavitation, and has reduced its effect by cutting down his diameter of propeller and increasing the pitch. Now, if we can reduce cavitation by reducing the diameter of the propeller, it shows that we do not know all we ought to about cavitation.

Mr. Kemble: As regards the *Napier II,* I am under the impression that she was not entirely satisfactory as to speed when she first came out, and that last winter the afterbody was entirely rebuilt. I would like to ask what has been the extent of the use of the turtle back as against the use of freeboard? Also as to what speed of propeller has been found to avoid cavitation, if any particular speed, or whether that depended more on the pressure per square inch of thrust than on the speed of revolution of the tips of the blade?

In regard to the reaction of the propeller, in talking to one of the French naval officers who was over here last year, he told me that there was a noticable heel to the vessel when running at high speed in smooth water, with the two propellers running in the same direction.

In the Whitehead torpedo, where you get the maximum heeling effect, they have to put on two screws running in opposite directions, to keep the thing from simply spinning.

A member: Referring to the comparison between the *Dixie* and the *Napier II,* Mr. Yarrow has shown apparently that the form of the *Napier II* was easier driven, but on the other hand, it is much worse in a sea way. A point which I think is very interesting in the paper is that point of reference to the reaction of the screw. I have heard of only one other instance where this took place, namely in the case of a French racing cutter *Debonnaire,* about a 60-footer, with an engine of about 300 horsepower. Although the engine was designed to run at 700 revolutions, they were unable to get it up over 500, on account of this point. I would like to ask Mr. Crane if he has ever figured it in terms of the engine power or general terms of stability, instead of weight.

Mr. Stevens: It seems to me that the heel produced by the action of the propeller is, theoretically, a problem very easily solved; but practically when you come to apply it to a vessel you will find that the results depend almost entirely on the form of the hull, and on the conditions under which the propeller is working; so that it has been one of the subjects that has given the designers of small boats more trouble than almost any other.

Mr. Du Bosque: It seems to me that the upsetting motion of the boat is very small, or is simply the turning over of the crank by the friction of the thrust bearing. It doesn't require any action of the propeller whatever, because the thrust bearing is what is taking the twist moment.

Mr. Crane: The question has been raised about the *Napier II.* I know that she was not a success the first year. I have hearsay information that the reason was that she went heavier than she was designed to be, and that during the winter they changed the stern slightly to take care of the extra immersion, and after that she was a success. I have never put a turtle back on with the idea of making a boat a better sea boat. I believe in carrying the prow up as far as is necessary. The turtle back is simply a court of last appeal. I have been on one of these boats driving into a heavy sea, and I have come very near driving the bow under entirely. It occurred to me it would be better to have a rounded turtleback to strike the water than a flat deck.

Cavitation is one of the things that "now you think you have it, and then you find you haven't." It seems logical enough to say that it is very easy to figure your pressure per square inch of projected surface under 11 pounds, and thus avoid cavitation. I have found that that is not so. The next thing that at once occurred to me was that cavitation must be due to the peripheral speed of the wheel. I had last winter the very anomalous case of getting cavitation with a 20-inch wheel, and replacing it with a 19-inch wheel, and not getting it. It seems to me that the shape of the blade itself, and especially the cross-section of the blade, has more to do with cavitation than has usually been believed.

The horsepower of these various motors is—unless you have actually seen a test—something that you cannot be very sure of. I think we can be reasonably certain that with the same size of cylinders and the same character of workmanship, and the same high class builder, your power is about the same. The *Dixie's* engine has never been indicated, and whether it develops 140 or 150 or 180 horsepower is a matter of taste. You can take which you choose.

The question of torque is not a new one. The single screw torpedo boats were all so troubled. The way I figure the torque is simply to resolve the brake horsepower of the engine, and that gives me a certain twisting moment. This boat happens to be five feet wide. If you multiply 2½ by 350 you get the moment of torque. That is not absolutely accurate, but it is probably as near to it as we can get. There seems no doubt in my mind, after the developments of this summer, that in those extremely high power boats you have got to use a stern which will statically resist heeling.

PROGRESSIVE SPEED TRIALS OF THE GASOLINE LAUNCH LUDO.

BY GEORGE CROUSE COOK, MEMBER.

ABSTRACT.

The length of the hull between perpendiculars is 25 feet; maximum beam, 4 feet ½ inch; depth at half length, 2 feet 4 inches; draft of hull forward 1 foot 1¼ inch; the displacement on trial was 2,144 pounds. Six double runs were made, alternately against and with the tide, at revolutions averaging respectively 180, 296, 424, 452, 506 and 540 per minute, and with corresponding mean speeds of 6.67, 8.5, 11.44, 12.24, 14.01 and 15.33 miles per hour.

A prominent feature of the figures and the curve of speed-revolutions is the slow increase of speed for increased revolutions at low speeds, and the rapid increase of speed for comparatively slight increase of revolutions at the higher speeds. This feature, so at variance with that usually observed in ordinary work, together with the shortcomings of the rule for estimating the horse-power-revolutions, leads to odd developments in the speed coefficient curve based on the Admiralty formula. In this latter curve there is a marked increase of the coefficient for the higher speeds, and, in fact, it reaches a maximum, showing maximum efficiency, at the top speed.

SCANTLING REGULATION IN YACHTING.

BY W. P. STEPHENS, ASSOCIATE.

ABSTRACT.

It is only about 1880 that we find the first indications of the principle which is accepted to-day as the proper basis of all measurement legislation: the accurate appraisement in a formula of a number of the elements of speed, size and power, leaving it to the skill and judgment of each designer to select each in a certain proportion so long as the total be within the limit of the class in question. Two vital principles of successful legislation are that yacht racing can flourish only when the tendency to extreme over-development is restrained by suitable rules; and that a measurement rule to be effective must be based upon some approximately accurate valuation of the largest number of factors which may be handled without too much complication.

The first attempts at the regulation of construction date back about twenty years, being coincident with the establishment of the now popular one-design or monotype classes. It must be recognized that beyond a certain point light construction in yachting is purely an economic and not a technical problem. Backed by adequate scantling restrictions, even an indifferent rule may work well in practice; but it is evident that no rule, however perfect, can meet the desired end of promoting a wholesome type of all-round racing yacht unless it be reinforced by some regulation of construction.

METHODS OF CONDUCTING SPEED TRIALS.

BY NAVAL CONSTRUCTOR J. J. WOODWARD, U.S.N., MEMBER.

ABSTRACT.

The determination of the true speed of a vessel through the water is one of those numerous problems for which we have only approximate and not exact solutions. The indications of the patent log are subject to sudden fluctuations of unknown amounts owing to changes in its internal friction; on the other hand, the ship's propeller, considered as a speed recorder, is affected only slightly by changes in internal friction of the machinery, and will give accurate comparative results, *provided* external conditions which affect the economy of propulsion remain the same. That is, if the displacement, condition of the bottom, effect of the wind upon the vessel, etc., remain the same, then the number of revolutions of the ship's propeller permits an accurate determination of speed, provided we know exactly what speed has been developed over a measured base under exactly similar conditions. Without such similarity of external conditions, speeds based upon the revolutions of the ship's propeller are entirely fallacious.

In determining the speed of a vessel during any of the contract trials, the double run over a long measured course at sea can give reliable results only in a tideless sea. When tidal currents do exist the errors introduced by the attempt to measure the current are of the same order of importance as the effect of the current itself. When the results of the standardization trial are applied to the observations made on a four-hour run at sea, an error is introduced into the speed so obtained, owing to the difference in the state of the wind and sea at the times the two trials are held. The resulting error is, however, as slight in amount as such a variation in the external conditions must necessarily cause with any method of trial.

The beacons for a measured base line should have a base of ample size so that they can be immediately located from the ship by the unaided eye. Each pole should be surmounted by a small pyramidal shape to assist in distinguishing it at a distance. The images of the poles of the front and back beacons should transit across each other, as viewed from the ship when crossing the range.

DISCUSSION.

MR. STEVENS: Taking up the detail of trial trips, I do not see any safeguard mentioned for insuring accuracy in the trial. In several instances I have found runs which when reduced fail to plot with the other spots. I also fail to notice any reference to slack water, which I have found a very disturbing element in getting accurate results. Of course, we will all admit that the important point for the shipbuilder, under the contract for speed, is the high speed point. Perhaps the next point in importance in the curve is the low speed point. The unfortunate part is that that point is not really low enough to allow of making a close estimate of the internal friction of the engine by well known methods, and, of course, at that low point the question of speed is not of very vital importance, unless it comes into propeller design. The main question there becomes one of accurate observations of revolutions and M. E. P. I have also at those two extreme points—the very high and the very low—found trouble in trial trips in knowing that I was getting a steady revolution of the engine. Many things will happen on board a vessel that we do not notice in the engine room in taking cards, that considerably disturb the relation between the revolutions and the M. E. P. of the cylinders. I have found that I can detect in the engine room, by using a magneto at the shaft with an ordinary voltmeter, a very slight motion of the steering wheel. One other question is the importance of progressive trials, not only to the designer, but to the owner and operator. Boats have been operated for years with propellers of very great inefficiency, which were requiring much more work for given speed, and consequently a much larger coal bill than was necessary to get the results.

Mr. Bowles: Why is it that the navy takes such a fierce interest in what these vessels can do while they are in the contractors' hands, and then continues to have these vessels in their own hands until they are worn out, without doing any of these things? I believe that the contract trials of any vessel should justly and properly be made as simple as will prove that the ship is what it was intended to be, and that there should be no unnecessary elaboration or expense or delay involved in it. At the same time, I believe it to be best for all concerned that at some time in that vessel's history there should be a thorough and complete trial. I do not believe, however, that it should be made at the expense of the contractor. The present method of conducting contract trials is undoubtedly inadequate from any point of view; that is, the result to be obtained is simply one of speed. The consequence is that there is little field for engineering ambition—to put it broadly—in a trial of that kind. It is a narrowing development, and no doubt it should be somewhat changed. One of the serious things which have been brought out recently, as the cost and complexity and size of naval vessels increase, is that it is an unwise risk on the part of the owner to take out a vessel costing seven million dollars in the hands of a scratch crew, and probably would not be considered for a moment by any owner other than the government. I believe that all contract trials for naval vessels should be conducted with a United States naval crew on board. It would be good for the crew and it would be decent to the contractor.

Professor Peabody: This is a good opportunity for urging the great value of well made progressive speed trials for the naval architect who has in hand the powering of a new ship; and in particular, we may ask of what avail are the elaborate scientific investigations of our model basin if there are not afforded ample opportunitites of comparison of tests on models with tests on full-sized ships. True, the contractor should not be forced to pay for scientific information for the good of the government; but we have the suggestion that all trials be made at government expense, and trials sufficient for standardization of screws need but little amplification to cover the entire investigation desired.

The irregularities and inconsistencies of tidal current measurements are to me most startling, and while it may be that service conditions preclude any hope of improvement, I find it difficult to believe that more regular and consistent results are not attainable, provided that a study of the subject be undertaken by skilled observers. Part of the difficulty is, without doubt, chargeable to the real irregularity of the currents, for it is well known that eddies and undulations once impressed on a current persist a long distance. It may be noted that the ship averages the total influence both by her size and her progress. The great importance of properly marked ranges and desirable conditions for speed trials has been impressed on my mind by a varying experience of running such trials under all kinds of conditions, usually unfavorable on account of the necessity of taking the boats and ships tested when they could be borrowed.

For the present purpose, the determination of power is of secondary importance; but in the general subject of speed trials it is, to my mind, the most important for a naval architect, for upon proper power determinations depend his future success in powering ships. All the other errors of power and speed tests when conditions are at all favorable sink into insignificance when compared with the error and uncertainty of the determination of the power, because we are compelled to depend on the indicator, which at best is but a coarse instrument, and which is liable to fail us altogether if conditions are unfavorable. Now, of all the errors of the ordinary indicator with enclosed spring, when skillfully used, the worst is that due to the change of temperature of the spring. Outside spring indicators should, in my opinion, be used for all important work. At least three diagrams should be taken on the course. I am very suspicious of the stop watch, and favor the use of a chronograph, which may be a comparatively simple and inexpensive instrument, since we have no occasion for astronomical accuracy.

Mr. Hyde: Our company has been consistently in favor of the standardization method of trial. The contract practically provides that the contractor is judged by his performance on trial. It is therefore vital to him that the speed be as great as possible. We have always believed that standardization trials mean greater accuracy. It is true that this trial is more expensive to the contractor, but to me it seems that the greater accuracy is worth the difference in cost. There are also other advantages—if anything arises after the standardization trial so that it is necessary for the vessel to be returned to the contractor, it is not necessary for them to go over a measured course at a long distance. They can run it at some convenient point near their own works.

Mr. Weatherby: I cannot see the value of taking indicator cards on the progressive trial. Under those circumstances the man who is taking the indicator cards is limited in the time in which he can perform this operation to the time during which the ship is on the mile, and frequently it is hard to obtain good cards. I think that the proper way to obtain the power curve is to run the ship in the open sea, keeping her on a steady course, with the wind and sea abeam. Then the man who is taking the indicator cards can give his instructions to the chief of the engine room, stating that he wants so many revolutions. When he has a sufficient number of suitable cards he can give an order to have some other number of revolutions. In that way you are sure of accurate indicator cards.

I believe that the high runs of the standardization trial should be made at the end of the trial; for it is necessary to steam at least an hour and a half after leaving anchorage before the ship is in condition for the high run. That gradual warming up might just as well take place over the measured mile as to be used up in cruising around, and by so doing, after the ship has been under steam from two to three hours, you are in position for your high-speed runs.

Mr. Woodward: On all trials as at present conducted, we have not only two buoys marking the points where the ship should cross the range, but there are in addition two approach buoys, so that when the ship is a mile from the point where the speed is to be measured the officer directing the course of the vessel has as a guide, on a bright day, when he can see the furthest buoy, four buoys, but always two in line, so that he gets his ship pointed in the proper direction, and carries the ship through exactly the same condition of depth of water. The matter of having a ship given the proper heading is very important because of the effect of small angles of helm. There is a tendency for the man who steers the ship to use the helm when he doesn't need to, if he would only remember that the one point involved is to steer the vessel on a compass course and not on a straight course through the water, with any set of the tide across the course.

From such observations as I have made, although sometimes the period of slack water is very undesirable, at other times the rate of change of the current is not as irregular at slack water as one would anticipate. In any event, the main point to be considered is that if we are going to use for the determination of contract speed of large vessels any course, there should be a thorough investigation as to the general character of the tidal currents on that course; an investigation lasting over one lunar month, and perhaps more, in order to get the best general information as to the tidal currents, and in addition, preceding any important trial, the observations of the current should be taken by a vessel the day before the trial begins, so that although our current measurements do not give us any real quantity, and although we use those records in no manner in the trial, still we have this information available, and it permits us to avoid the irregularity in the current.

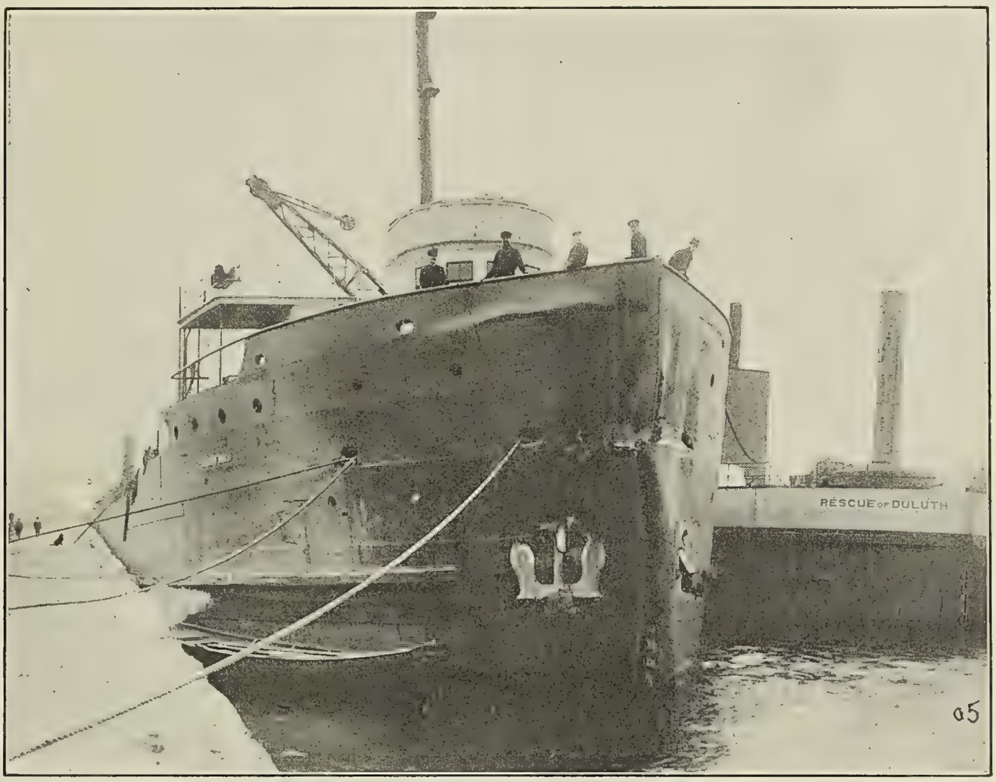
It is perfectly true that we are somewhat unique, I think, in making our contract requirements exclusively determined by speed; but anyone who has gone into the conditions will admit that there is less chance for conflict of interests, and generally that the determination of the observer by measuring speed, although by no means ideal, is much more reasonably accurate than the determination of horsepower, as a matter of insuring excellency to a certain degree. I think that if we had to apply penalties on horsepower there would be much more chance for difference of opinion than on speed.

In regard to the matter of making the high runs at the end of the trial or at the beginning of the trial, I think that is usually a question that depends on the thoroughness of drill and organization of the ship's company charged with the conduct of the machinery. There is a certain nervous tension on the part of an engineer who is responsible for operating this large machinery at a particular speed, when responsible to his employers for conducting the trial in such a way that it will not have to be repeated.

At a business meeting of the Society amendments to the constitution as proposed last year were adopted. The most radical change deals with the election of officers, and provides that the president shall serve for three years, and shall not be eligible to succeed himself. The vice-presidents will serve six years, and members of council three years. In both these latter classes arrangement is made whereby definite numbers of the terms of office end every year, so that by new elections the list is kept filled without any possibility of getting in an entire new and untried board. It is the same idea as that provided for filling seats in the Senate of the United States.

On the evening of Friday, November 17, the usual banquet took place at Delmonico's; the Society was addressed by a number of gentlemen, prominent among whom were Senator Jacob H. Gallinger, of New Hampshire, Chairman of the Merchant Marine Commission, and Rear Admiral Robley D. Evans, Commander of the North Atlantic Squadron.

On Saturday a large number of members and guests visited the works of the General Electric Company, at Schenectady, through courteous invitation of the company, and were afforded exceptional opportunities for a full inspection of the plant.



THE HARVARD, AFTER COLLISION WITH THE THOMAS W. PALMER.

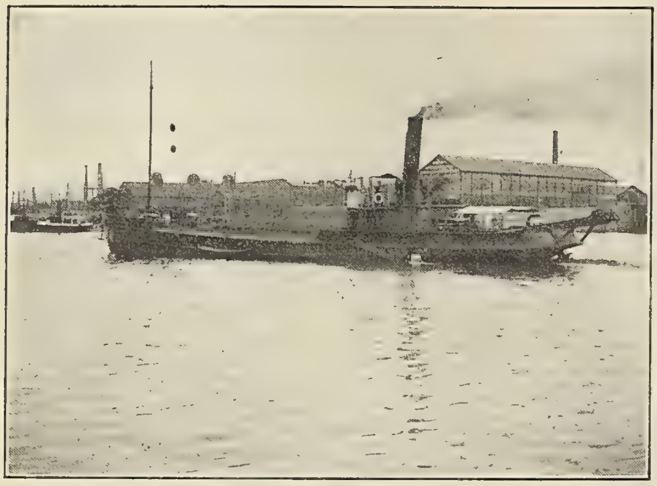
The Sinking of the Steamship Palmer on Lake Superior.

In a dense fog some fifty miles east of Copper harbor, the steamer *Thomas W. Palmer* was in collision May 16 with the steamer *Harvard*, and was sunk. The *Palmer* measured 281 feet in length, 41 feet beam, and 20 feet in depth, with a gross tonnage of 2,131. She was loaded with coal and was almost cut in two.

The *Harvard*, which sustained the damage shown in the accompanying photograph, is a steel freighter 461 feet long, 50 feet 2 inches beam, and 29 feet in depth, with a gross tonnage of 5,054. She was loaded with iron ore. Repairs to the *Harvard* were made by the American Shipbuilding Company at Cleveland.

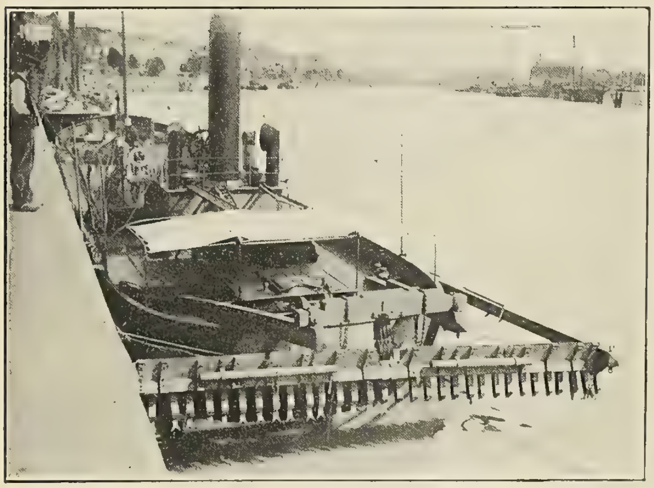
The Raking of a River.

The river Loire has sandy banks which cause a great deal of trouble at the time of the regular winter overflow by filling up the channel and entirely altering the course of deep water. It is thus necessary to keep continually dredging the river for a distance of about ten miles, over which the obstructions are met. The depth is kept at such a figure that ships of 18-feet draft can reach Nantes at any time, while at the highest tides ships of as much as 23 feet in draft can use the channel. One of the schemes for taking care of the considerable quantity of mud and débris which gets into the channel is indicated by means of the accompanying



THE RAKING DREDGE AT WORK.

photograph, showing a peculiar dredge with a rake attachment at the stern. This craft has a length of 131 feet, a beam of 23 feet, and a registered tonnage of 292, with machinery of 300 horsepower.



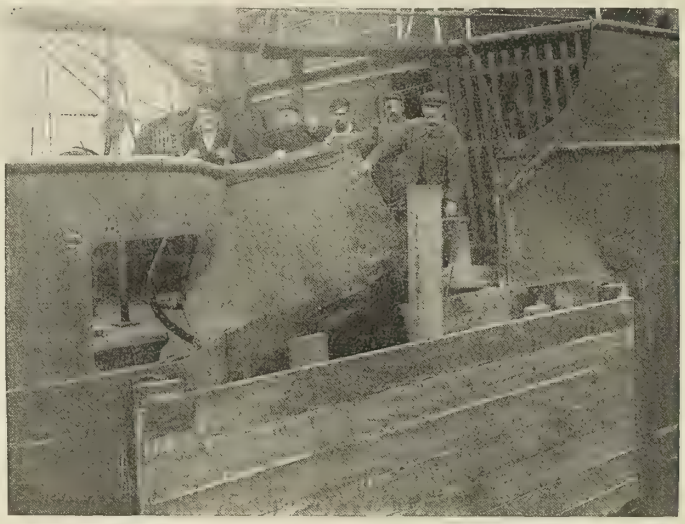
THE RAKING DEVICE RAISED FOR INSPECTION.

The rake has a length of 36 feet and a weight of 2.5 tons. During the ebb tide the steamer goes to the middle of the river and drops the rake, and then runs from Nantes to the entrance of the channel and back again until the next high water, by which time the rake has succeeded in so mixing up the mud with the water as to render it fluid. It is then carried out to sea by the tide going out.

The Minister Tak in Collision.

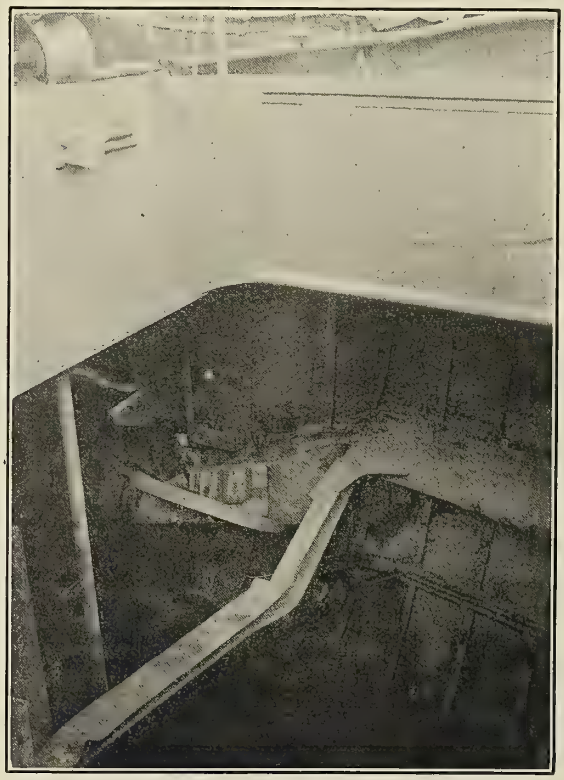
Early in September the steamship *Minister Tak* left Hull for Harlinger with a cargo of bales, and on nearing Grimsby she was run into on the starboard side by the steamship *Falka*, which was not seriously damaged. The *Minister Tak*, however, was badly injured under the water-line, and leaked very rapidly. She was beached on a mud bank near Grimsby, was patched up there temporarily with wood, and towed back to Hull, where the extent of the accident was ascertained, and she was placed in dry dock. The bulwark plating and main-deck stringer plate were badly broken, and there was a large hole in the main-deck sheer strake, this hole extending down the side of the ship to the bottom plating. One hold stringer was badly broken and a strong hold beam much twisted and broken.

The *Minister Tak* is a steel screw steamer measuring 205 feet 7 inches in length, 29 feet 2 inches in beam, and 14 feet 5 inches in depth. Her gross tonnage is 747 and net tonnage 380. She was built at Newcastle in 1891 by Messrs. W. Dobson & Sons. She is propelled by triple-expansion engines with cylinders measuring 19, 31, and 51 inches in diameter.



TEMPORARY REPAIRS ON THE MINISTER TAK.

The *Falka* is a steel screw steamer measuring 260 feet by 36 feet 7 inches by 18 feet 2 inches, and having a tonnage of 1,107 net and 1,744 gross. She was built in 1889 by W. Gray and Company, Limited, West Hartlepool, and is propelled by a triple-expansion engine with cylinders 19, 30½, and 51 inches in diameter and a common stroke of 36 inches.



DAMAGE TO HOLD BEAM IN MINISTER TAK.

The National Motor Boat and Sportsmen's Show in Madison Square Garden will be held this winter from February 20 to March 8 inclusive. There is great pressure for space, the applicants including nearly all of the old exhibitors and many new ones.

Superheated Steam Tests on Steamer James C. Wallace.

The subject of superheated steam has been so prominently before the engineering world of late that comparative tests showing the economy to be expected in the generation of power due to the installation of superheaters are of special interest and value. We give below the results of tests made during the past summer on the steamship *James C. Wallace*. This vessel is one of the largest of the modern ore carriers on the Great Lakes, being 552 feet in length over all, 56 feet beam, and 31 feet in depth, and during the trials described below she carried 10,400 tons of iron ore on a mean draft of 19 feet 4½ inches.

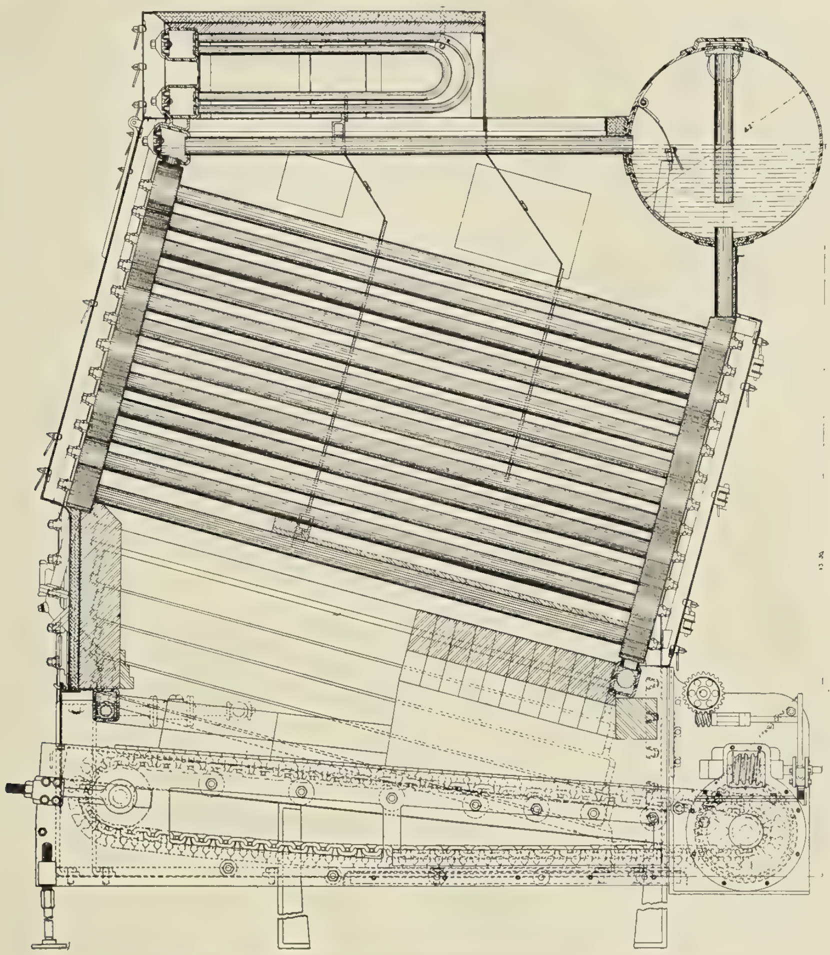
The machinery equipment includes one quadruple-expansion engine built by the American Shipbuilding Company, having cylinders 18½, 28½ 43½, and 66 inches in diameter, with a common stroke of 42 inches. Steam is supplied by two Babcock and Wilcox marine boilers, each having a heating surface of 2,900 square feet, and designed to carry a steam pressure of 250 pounds per square inch. Two stokers, built by the Duluth Stoker Company, are installed under each boiler, and a system of fan blowers is installed in the uptakes, so arranged as to provide induced draft at such times when natural draft is not sufficient to give the necessary data.

With these boilers, installed as part of the boiler equipment, there are two superheaters, one fitted to each boiler, each containing 414 square feet of heating surface. The steam, after being generated in the boilers, passes through these superheaters, where it is superheated approximately 90 degrees Fahrenheit, after which it passes directly to the engine and to the auxiliary machinery, all of the latter being operated separately and detached from the main engine. The piping is so arranged as to permit of the superheaters being by-passed and saturated steam being sent directly to the engine, the idea being to leave the ordinary saturated steam connections intact and make the superheater installation entirely separate and independent. This arrangement provides a ready method for changing the plant from one using superheated steam to one using saturated steam, the only changes required being the removal of one baffle plate and insertion of tiling under the superheater in such a way as to prevent all gases from entering the superheater, thus cutting it entirely out of service.

The fuel used was Pittsburg slack, having a heating value, as shown by calorimeter tests, of about 13,500 B.T.U. per pound of dry coal.

SUMMARY OF TESTS.

	Test I.	Test II.	Test III.	Test IV.
Duration, hours	8	6	8	6
Degrees of superheat: At boilers	86.9	92.1	0	0
At engine	81.7	88.0	0	0
Steam pressures, gauge: At boilers	237.6	241.2	237.3	238.7
At engine	233.7	240.4	234.6	237.8
At first receiver	94.2	95.4	101.2	90.2
At second receiver	34.1	34.3	38.	33.5
At third receiver	9.96	9.74	11.63	10.12
Vacuum, inches	24.5	24.9	24.6	24.6
Revolutions per minute	79	79.6	80.3	77
Cut off in cyls., fraction of stroke:				
H. P. cylinder	.574	.574	.574	.504
First I. P. cylinder	.659	.659	.647	.698
Second I. P. cylinder	.598	.598	.606	.64
L. P. cylinder	.605	.605	.556	.58
Mean effective pressures: H. P.	90.36	91.2	85.9	82.77
First I. P.	36.39	35.7	40.87	36.37
Second I. P.	16.06	16.78	18.44	17.27
L. P.	6.84	6.98	8.08	7.16
Indicated horsepower: H. P.	389.7	397.1	377.8	348.6
First I. P.	381.9	377.5	437.3	371.1
Second I. P.	396.7	413.1	461.6	412.5
L. P.	390.9	401.9	463.8	398.3
Total	1,559.2	1,589.6	1,740.5	1,530.5
Coal: Moisture, in percent	3.38	2.89	3.07	2.88
Per hour, as fired, lbs.	2,362.5	2,616.7	3,137.5	2,700
Per hour, per I. H. P. (moist), lbs.	1.515	1.646	1.803	1.764
Per hour, per I. H. P. (dry), lbs.	**1.464**	**1.598**	**1.747**	**1.713**
Per hour, per sq. ft. grate (moist). lbs.	15.96	17.68	21.2	18.24
Percent of ashes in coal	19.87	15.32	17.8	14.4
Kind of draft	Natural.	Induced.	Natural.	Natural
Draft (ins. water), base of smokepipe	.22	.42	.24	.22
Temp. at base of smokepipe, deg. F	485.3	499.6	557.1	553.5



BOILER OF JAMES C. WALLACE, WITH SUPERHEATER AND AUTOMATIC STOKER.

The first test was made with superheated steam, the engines being operated under the usual conditions, the cut-off in the high-pressure cylinder being 57 percent of the stroke. This resulted in 79 revolutions per minute and a total indicated horsepower of about 1,560. The superheat at the boilers was 87 degrees and at the engine throttle 82 degrees. The dry coal per indicated horsepower on the main engine, including the coal used in supplying steam for all the auxiliary machinery, amounted to 1.464 pounds.

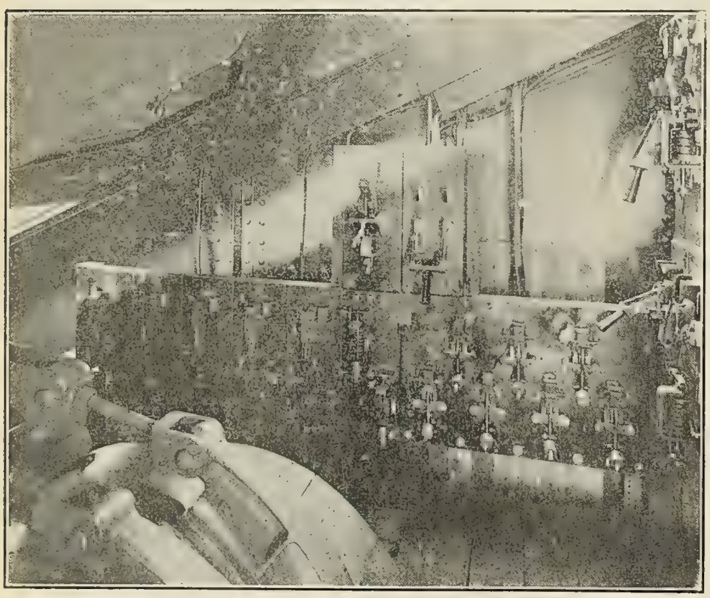
The second test was also made with superheated steam and all conditions remained the same, except that the induced-draft fans were in operation. In this test the superheat was a few degrees higher, being 92 degrees at the boilers and 88 degrees at the throttle, but the extra steam used by the fans, in addition to less economical furnace conditions due to excess of air through the fires, increased the coal per indicated horsepower to 1.598 pounds per hour.

The connections were then changed, so that saturated steam was sent to the engines and auxiliaries, and a third test was made under exactly the same conditions as test No. 1; that is, the cut-off in the high-pressure cylinder remained at 57 percent of the stroke, and the induced-draft fans were not in operation, natural draft being used.

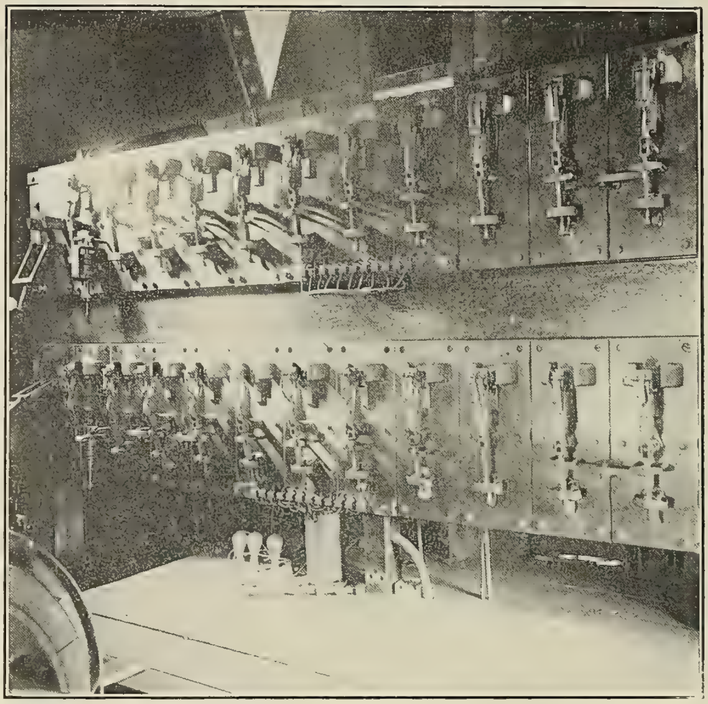
The first and last tests are the best for comparative purposes, showing the saving due to superheated steam when developing the same power. The dry coal per indicated horsepower in the last test amounted to 1.713, which, when compared with the test with superheated steam, shows a net saving in fuel under superheated steam of 14.5 percent. In other words, the installation of superheaters in this ship has produced a net saving of one-seventh of the fuel, all other conditions remaining the same, the same power being developed, and the same speed of vessel maintained, which in this instance averaged nearly 12 miles per hour. When it is considered that this represents a direct saving in the coal bill, it is evident that the use of superheaters is productive of one of the greatest economies which has been effected in steam generation in many years.

HULETT ORE UNLOADERS AT LORAIN.

One of the most interesting and notable examples of the remarkable advance in modern industrial appliances is that to be found in the ore-unloading equipment of the great lakes. The ore-unloading facilities of the great lakes are far in advance of those in any other part of the world, and at not even the largest ocean ports is reached the marvelous speed of unloading and handling which has been obtained at the lake docks. A notable



MAGNETIC CONTROLLER FOR OPERATION OF GRAB BUCKET.



MAGNETIC CONTROLLERS FOR HOIST AND TROLLEY TRAVEL.

type of the modern equipment employed for the purpose—in fact, the one holding the world's record for fast ore unloading—is the Hulett automatic ore unloader, built by the Wellman-Seaver-Morgan Company, Cleveland, O.

The general view herewith shows the latest installation of these unloaders: namely, two electrically-operated machines at the United States Steel Corporation National Tube Company's docks, Lorain, O. An idea of the heavy service required of these machines may be gathered from the fact that they rapidly handle an enormous grab bucket, which, when open, has a spread of over 18 feet, and which automatically digs and conveys from the hatches of the boat ten gross tons of iron ore at a load. This bucket, when open, can by telescopic motion be extended still farther, so as to reach more than half-way from the center of hatch to hatch. It is carried at the lower end of a vertical dependent leg suspended from a long pivoted walking beam, which is carried on a carriage or trolley traveling back and forth on the girders of the machine. The operator who controls all the motions of the bucket rides at the lower end of the leg directly above the bucket. By means of hoisting mechanism the walking beam is made to oscillate up and down, carrying the bucket down into the hold of the boat and up again above the dock. The leg carrying the bucket is mounted on rotating trunnions in the walking beam, so that it can rotate in a circle when operating in the hold of the vessel, permitting the bucket to reach out in all directions. It also travels lengthwise of the hatch to the sides of the boat; consequently the operator is able to reach almost the entire cargo. The travel of the trolley back and forth on the girders carries the walking beam with the bucket out over the boat and back over the dock. To reduce the trolley travel as much as possible, suitable hoppers for receiving the contents of the bucket are mounted between the girders at the front; these hoppers discharge into an auxiliary bucket car.

The Hulett unloaders at Lorain are provided with special cantilever extensions, designed particularly for delivering the ore on a high bank back of the machines. The bucket car travels on these cantilever extensions, automatically dumping the ore at any desired point, and returning closed to its position under the hopper. The entire machine is mounted on moving trucks, enabling it to travel up and down the dock from hatch to hatch without moving the boat.

The controlling devices for machines of this type are in all cases specially constructed to meet the conditions. The controllers, proper, for this unloader, consist of a number of magnetically-operated clapper switches, which cut resistance in and out of the motor circuits. The switches are operated by solenoids placed on the back of the switch panel. The main contact of each switch is a heavy laminated copper brush, reinforced with a yellow brass contact, the final break being taken between carbon contacts, and the arc is quickly ruptured by a powerful magnetic blow out. The switches are controlled by small master switches located in the operators' cabs. As the solenoids of the switches require but few amperes, the wires connecting the master switches with the controller proper are of very small size.

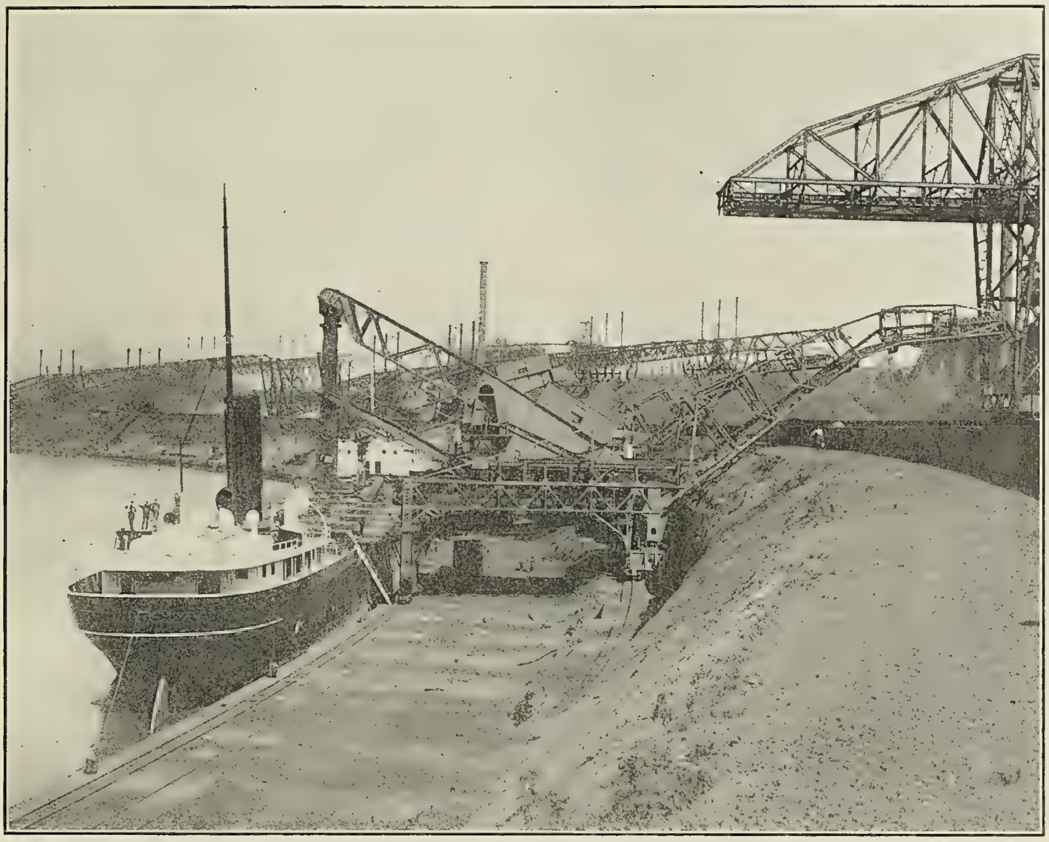
Each motion of the unloaders is provided with a positively connected or geared automatic cut out or emergency switch. The cut outs on the hoist and bucket-car motions automatically slow down and stop these motions as the limits of travel are reached. They first operate to gradually introduce resistance and slow down the motor; then change connections to convert the motor into a generator, and apply a gradual dynamic breaking effect, until the motion is nearly stopped, and finally apply band brakes. The application of dynamic braking to the above-mentioned motions is of particular advantage, as the energy of these heavy parts is absorbed and dissipated in the resistance, thus removing practically all wear from the solenoid band brakes. Under these conditions the band brakes operate as holding brakes, and are required to stop the motion only upon failure of current supply.

The bucket rotation and trolley motions are supplied with geared automatic slow down and cut out devices, which gradually insert the resistance, and finally apply solenoid band brakes to stop the motion as the limits of travel are approached.

While all of these automatic devices fully protect the machinery and motors against failure of current supply, confusion, and faults of the operator, still they allow the operator full control of the motors at all times, except that he is unable to pass a predetermined limit of travel of the motions.

The main controllers are located as near to their respective motors as possible, so that the heavy wires carrying large currents are made as short as possible. The master switches or controllers are small, thus allowing such an arrangement that all operating handles are brought within easy reach. They are very easily worked and do not fatigue the operator, thus allowing full output of the machines at all times irrespective of the physical condition of the operator.

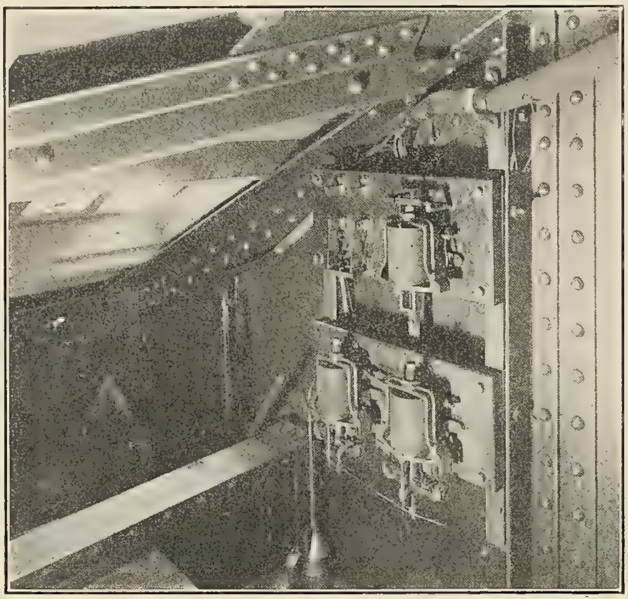
The magnetic controllers, which control the movement of the bucket in and out of the boat, and the raising and lowering of this bucket, are shown. To the left there are seen four pairs of two switches each, interconnected by means of horizontal levers. These are the reversing switches, and the function of the levers is to absolutely prevent the closing of both reversing switches at the same time. To the right are seen two switches interconnected by means of two levers. The functions of these levers is to prevent the closure of the middle or dynamic breaking switch when the motor is still connected to the line and operating as a motor. The levers are also used to hold open the switches at either side of the center switch when the motor is acting as a generator with the center switch closed.



HULETT UNLOADERS ON DOCKS OF LORAIN STEEL COMPANY.

Another photograph shows the magnetic switch controller for the operation of the grab or clam-shell bucket. The smaller switches, at the left, are the accelerating or resistance switches. These switches are so connected that each succeeding one depends for its closure upon that of the one preceding. One terminal of the operating solenoid of each switch is connected to such a point on the resistance that the current, taken by the motor upon the closing of the preceding switch, must fall to a certain predetermined value before the following switch can close. This means that the motor must come up to a speed corresponding to each accelerating switch before the following switch will close. This results in the smoothest possible acceleration in the shortest possible time consistent with safety to motor and driving mechanism, and makes acceleration of the motor entirely independent of the operator should he throw the master switch with extreme rapidity.

The result of this design is to cause the motor to approximate almost exactly the operation of a hydraulic or steam cylinder; that is, it will keep a predetermined pressure on the bucket jaws and will not exceed this pressure. The motor is generally stalled once during every closure of the bucket, and this occurs without injury to the motor, controller, or attached mechanism.



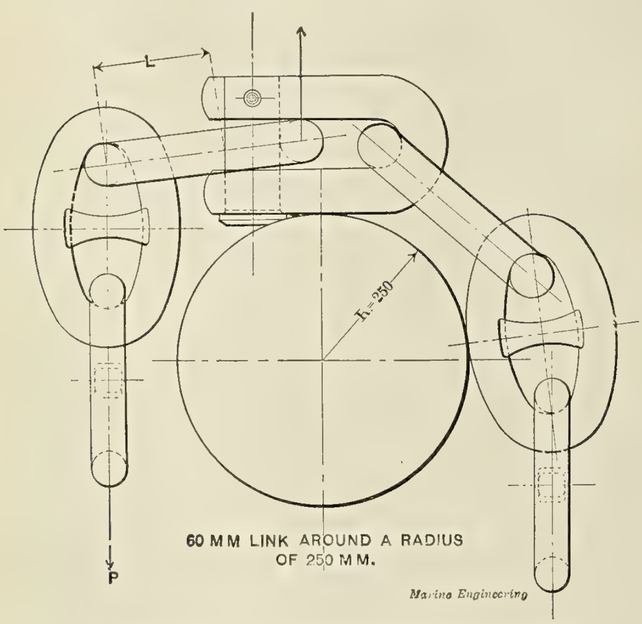
MAGNETIC CONTROLLER FOR BUCKET ROTATION MOTOR.

The master controller for operating the bucket rotation motor is shown in another view. This motion operates so easily that the controller is small and requires but few steps.

CHAIN CABLE JOINING SHACKLE.

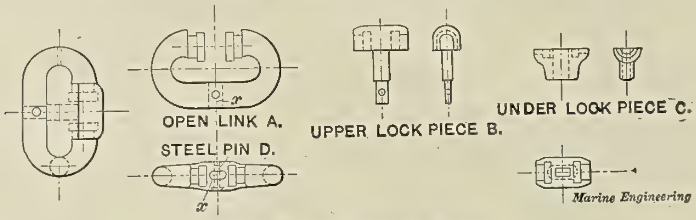
BY A. VOLLBRANDT.

In connection with the continual endeavors to increase the safety of ships, particular care has been taken to improve their anchor arrangements. Many propositions have been made with regard to the improvement of the existing chain cable joining shackles, from the ordinary construction of which very frequent chain fractures result. It is generally known that the chain cable shackle everywhere in use, as illustrated, is employed for joining lengths of chain with a single chain. It is, however, considered as extremely disadvantageous, for the following reasons:



THE PRESENT TYPE OF SHACKLE SUBJECTED TO BENDING STRAIN.

In the first place, the shackle cannot be used, in its present shape, for joining two chain cables composed of stud links. This is not only on account of the large dimension of the eye, in which the bolt is fixed, but also on account of the abnormal size of the shackle bolt. One is forced, therefore, to fit both ends of each length of chain with a long link and a middle-sized link, in order to be able to join the chain with the shackle. It results that only complete lengths of chain can be joined on board, and that the fracture of even a single link forces one to replace the whole length of chain. Thus we not only increase the manufacturing difficulties, but also find it a necessity to have spare lengths of chain on board, making a superfluous load for the ship.



DETAILS OF NEW TYPE OF SHACKLE.

In the second place the shackle, together with the abnormal long links, sliding over the anchor gear, cause shocks and stops of the chain; this has to be taken under consideration not only when making, but also when working the ground tackle. These shocks result, on the other hand, from the length and breadth of the shackle not being made to fit in the grooves of the capstan, so that the shackle sliding over the anchor gear jumps over these grooves; and, on the other hand, from the shackle stopping behind projections of the hull or of the anchor gear. In consequence of these reiterated shocks and jumps of the chain, it is always more or less overloaded, breaking frequently; not only very vexatious interruptions of work, but also expensive repairs result.

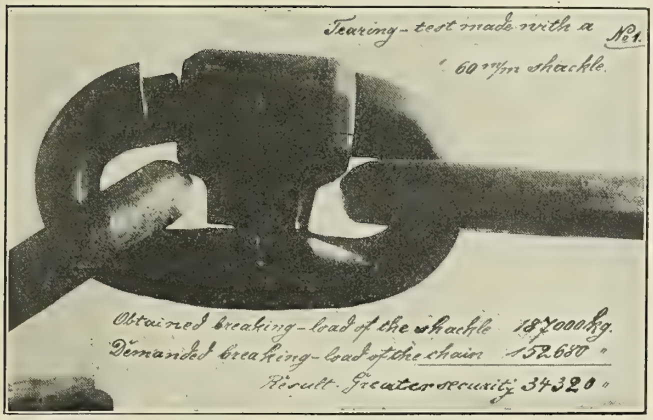
But the greatest disadvantage of the existing shackle is its lack of flexibility, and its limited durability. This lack of flexibility causing a dangerous effect of the lever working between the shackle and the long link is illustrated, showing the necessity of providing for an exceptionally large diameter of the capstan, and also for the rounded pieces of the hawse holes and tubing pipes being exceptionally large, that the joining shackle may slide over the anchor gear without getting caught. The sketch shows that bending strains arise in the jointing, if the radius is too small, and there is no doubt that, at a sudden shock, the force P working on the lever arm L may bend the long link and break the shackle. There is sufficient proof for the fact that such bending strains arise, and it is also proved that link fractures occur more rarely than shackle fractures.

In order to find out what resistance the shackle opposes to the bending strain, shackles made of different materials were tested to their bending limits, as shown. The shackles tested in this way broke in the rounded section after being subjected to relatively light loads, viz., $\frac{1}{5}$ to $\frac{1}{7}$ of the required breaking load. These bending-strain tests have further proved that new shackles, annealed or not, may be bent very much more than those which have been used for some time, and that it is better to make the shackles of soft Siemens-Martin steel than of crucible steel.

The shock resulting from the heaving back of the chain has an essential influence upon the durability of the shackle, for simple tests made by exposing a shackle to the effect of a falling weight of 60-kilogrammeters energy proved that both sides of the shackle being bent left very strong shearing impressions on the pin. That explains, on the one hand, the frequent shearing of pins used but a short time, and, on the other hand, the insignificant bending of the used shackle, because, in consequence of the frequent shock effect and the lever effect of the long link the bending produces changes in the material structure of the rounded part of the shackle.

Considering these defects, which are generally known, endeavors have been made to replace this defective form of shackle by a better one.

A newly patented shackle of compact construction, for the making of which in Germany, Great Britain, and Russia the firm "Duisburger Maschinenbau-Actiengesellschaft, vorm. Bechem & Ketman" has obtained a license, has the form of a stud link. Its dimensions (length and breadth) are similar to those of a middle-sized link, and the thickness of the lock piece is only 1.5 *a* instead of 2.8 *a* of the old shackle head, *a* being the thickness of the chain.



SHACKLE PULLED APART IN TEST.

This patented shackle is composed of an open link *a*, the open ends of which are fitted with upper gudgeons, and of the upper and under lock piece. The upper lock piece *b* having the form of hood or cap, covers the upper gudgeons, and goes through the under lock piece *c*; the end of the upper lock piece *b* is fitted with a conical taper catching in an opening *X* of the open link *a*. The under lock piece *c* envelops the under part of the upper gudgeons, serving at the same time as stud and preventing a contraction of the link. The pin *d* serves only to prevent the upper lock piece from falling out. In consequence of the composition and arrangement of the lock piece the fixing pin may be light.

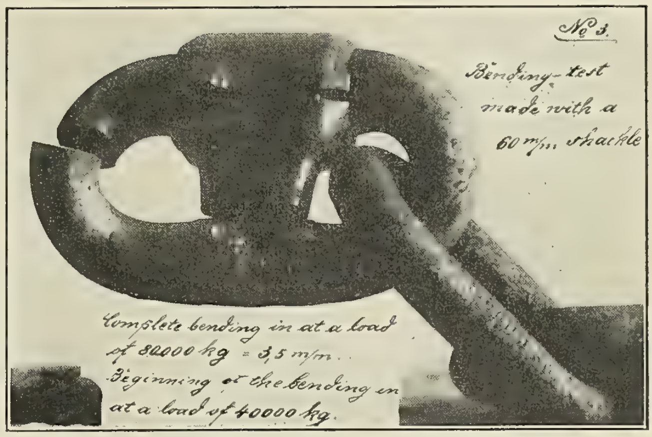
Trials have proved that these new joining shackles can be employed for new chains as well as for old ones for joining ordinary stud links, so that these shackles may be used as ordinary joining links, and also as spare links, avoiding thus the employment of abnormal long links. The suppression of the long links and middle-sized links not only simplifies the making of the shackle, but the possibility of using the shackle as a spare link dispenses also with the necessity of replacing whole lengths of chain in case of chain fractures. Ships need therefore not carry a stock of lengths of chain on board.

Trials made on board a ship of the German Navy for the purpose of determining the handling facility of the shackle have proved that it can slide in any position over the capstan without getting caught. In consequence of the smooth running and the handling facility of the chain, its load will in future be uniform, so that chain fractures need happen rarely.

But the greatest advantage of the new shackle is its great durability; a tearing test made with the chain-test engine in order to find the absolute resistance of the shackle has surpassed the highest expectation. During this test, a joining shackle of 60 mm. proved to be able to stand a load of 187,000 kg., and its broken section proved to have a resistance of 29 kg. per square mm., *i.e.*, 2 kg. per square mm. more than demanded, and 34,320 kg. more than the breaking load of the chain.

In order to see if it would be easy to disengage the shackle even after being heavily loaded the following test was made:

After testing the chain to a trial load of 102,000 kg. and a breaking load of 152,000 kg., the tests were stopped and the shackle closely examined. This examination proved that it was very easy



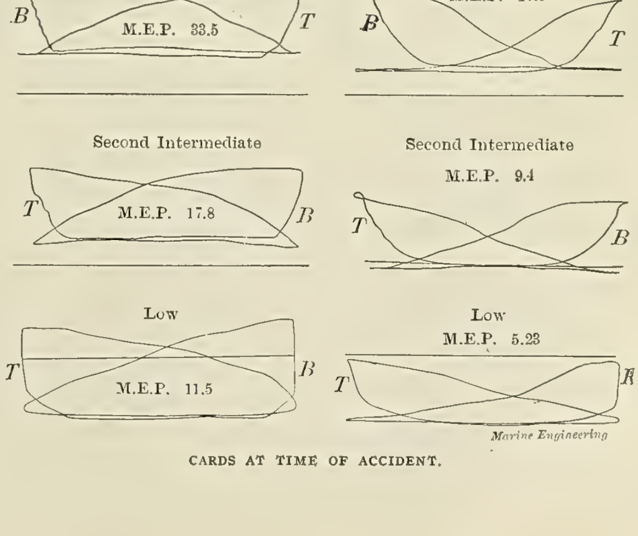
SHACKLE TESTED TO DESTRUCTION.

to disengage the shackle in both cases, and that alterations of the form of the shackle and the lock piece could not be detected. The links of 60 mm. loaded with 159,000 kg. broke, but even after that it was very easy to disengage the shackle and to take off the elongated links. The examination proved further that, even after the breaking of the shackle, the lock piece was quite unhurt.

Accident to the Königin Luise.

BY W. KIRCHBERGER.

On August 5 the *Königin Luise* left New York for Genoa, and about 8 o'clock on the evening of the 8th she was brought suddenly to a stop by reason of an accident to one of her propellers. Investigation developed the fact that one blade of the port three-bladed propeller had broken off, resulting in increasing the revolutions of that engine (due to partial racing) from 77 per minute to about 90. After the investigation had developed the fact that no damage to the ship had resulted, the voyage was resumed at a reduced speed corresponding with about 63 revolutions per minute, the new speed being about 13 knots. The cards taken from the engines at the time of the accident are rather interesting, and we are reproducing some of them herewith.



CARDS AT TIME OF ACCIDENT.

The *Königin Luise* has a length of 523 feet, a breadth of 60 feet, depth 34 feet, and measures 10,710 tons gross. The twin screws are of a diameter of 19 feet with a pitch of 21 feet 8 inches, and have a projected blade area of 67.3 square feet and a developed area of 80 square feet. They are propelled by quadruple-expansion engines with cylinders measuring 25.2, 38.2, 52.4, and 75.5 inches, with a common stroke of 55.2 inches. These engines develop 7,200 horsepower on a consumption of 118 tons of coal per day. This figures out as 1.52 pounds per indicated horsepower per hour, while the power is sufficient to give the ship a normal speed of 15.3 knots. After the reduction in speed was made the engines developed 4,900 horsepower on a consumption of 98 tons of coal per day, or 1.84 pounds per indicated horsepower per hour. Another element of change in connection with the reduction of speed was a quicker cut-off in the cylinders of the port engine to correspond with the smaller amount of power which could be absorbed by that propeller. This item is shown as follows:

Cylinder.	Starboard Engine.			Port Engine.		
	Cut-off.	Initial Pressure.	H. P.	Cut off.	Initial Pressure.	H. P.
H. P.	.70	209	856	.53	205	298
I. P. (1)	.65	92	789	.50	81	346
I. P. (2)	.65	37	794	.50	29	356
L. P.	.60	8.5	1 072	.48	2.1	417

The vacuum into which the starboard engine exhausted its steam measured 25.6 inches, while the port condenser gave a vacuum of 27.8 inches of mercury. Temperature of sea water and of feed water respectively were 21 and 97 degrees Centigrade (70 and 207 degrees Fahrenheit).

THE STEAMBOAT WATERS READY FOR LAUNCHING.

A Steam Yacht on Yellowstone Lake.

The yacht *E. C. Waters*, which has been built and put in service by the Yellowstone Lake Boat Company, of Yellowstone Park, Wyoming, is navigating on water 8,000 feet above the level of the sea, and, therefore, without any question the highest navigated water in the United States. Indeed, with the sole exception of Lake Titicaca, in Peru, which has an elevation of 13,000 feet, this is probably the highest navigated water on the globe. The *Waters* was built in a yard on the shores of the lake, being constructed of wood hauled over the mountain road from Gardiner, Montana. The keel and frames are of oak, planking and ceiling of Oregon pine. The length of the boat over all is 135 feet; length on water-line 120 feet; beam 26 feet; depth of hold 9 feet, and draft 8 feet.

The motive power for this boat was built by the Montague Iron Works, of Montague, Mich., and consists in a modern fore-and-aft compound condensing engine with cylinders measuring 14 and 28 inches and a stroke of 20 inches. The high-pressure cylinder is fitted with piston valve and the low-pressure with a double-ported slide valve, both valves being operated by a Stephenson link motion with adjustable cut-off. A direct-connected pump worked from the low-pressure crosshead operates a jet condenser on the aft side of engine. The usual type of horseshoe thrust bearings, steam reversing gear and independent feed and bilge pumps are fitted. Steam is supplied by two Scotch marine boilers furnished with corrugated furnaces designed for wood fuel. The boilers have a diameter of 6 feet and a length of 12 feet, and have been designed for a working pressure of 120 pounds. They were built by Johnson Bros., of Ferrysburg, Mich. The propeller has a diameter of 6 feet and is built of steel; the speed expected is twelve miles per hour.

Accommodation is provided for 600 passengers, the main deck being given over to freight, baggage, engine, boiler, and toilet rooms, while the passenger saloon and a liberal promenade space are to be found upon the saloon deck. The service of the boat will be to carry passengers from the Thumb to the Lake Hotel, thus enabling them to avoid the dusty fifteen-mile stage ride over the Continental Divide.

The boat is named after the president of the Yellowstone Lake Boat Company, which has been engaged in boat transportation on the lake since 1899, when the steamer *Zillah* was placed in service. The *Zillah* has a steel hull which was built and then knocked down and the pieces hauled from Gardiner to the lake, it being found necessary to enlarge the mountain pass at several places and to brace up the roadway in order to move the heavy loads through. A part of the equipment of the shipyard on the shores of the lake includes a marine railway designed for hauling out this steamer.

THE MEXICAN GUNBOATS AT GENOA.

Mexican Gunboats Bravo and Morelos.

In our January number of this year was published a photograph showing the launching of one of these new gunboats, built by Messrs. Odero, at Sestri Ponente, near Genoa, Italy. The ships have now been delivered to the Mexican government and are in service. They have a length of 250 feet, a beam of 34 feet, depth of 16 feet, and displacement of 1,280 tons, and are given very light draft for navigating the shallow rivers of the Mexican coast. They are furnished with twin screws operated by triple-expansion engines of 2,600 horsepower, designed to give a speed of 17 knots. The bunker capacity is sufficient for an endurance of 5,000 nautical miles at a speed of 10 knots.

The cylinder diameters are 15¾, 24⅜, and 37¾ inches, with a common stroke of 19⅝ inches; the revolutions are 265 per minute. The piston rods have a diameter of 3⅜ inches; crank shafts 6½ inches; crank pins 7⅛ inches, and propeller shafts 7 inches; the connecting rods have a length between centers of 44¼ inches. There are seven thrust collars with an aggregate thrust surface of 2 square feet. The air pump is of the Edwards pattern, measuring 13¾ by 10 inches. A centrifugal pump with a runner diameter of 15¾ inches is actuated by a steam engine 4$\frac{1}{16}$ by 4 inches. The two surface condensers have each a cooling surface of 1,362 square feet. The number of tubes in each condenser is 1,436, the diameters being respectively 14 millimeters external and 12.4 internal. The length between tube plates is 6

GUNBOATS BRAVO AND MORELOS.

feet 6 inches. The main steam pipe has a diameter of 5 inches and a thickness of 5 millimeters. The propellers are of manganese bronze, three-bladed, with a diameter of 8 feet 2 inches, a pitch of 7 feet 4½ inches, a pitch ratio of 0.903, and a projected area of 16 square feet. The Blechynden water-tube boilers, which are two in number, have a length of 11 feet 8 inches and a width of 7 feet 2 inches; each boiler has one furnace with a grate surface of 59 square feet. The total heating surface is 5,920 square feet, giving a ratio of heating surface to grate surface of 50.1 to 1, and a heating surface of 2.27 square feet for each indicated horsepower. The working pressure is 230 pounds. The wetted surface of the ship is 8,557 square feet.

Two 4-inch rapid-fire guns furnished by the Bethlehem Steel Company are mounted on poop and forecastle respectively with an arc of fire of 150 degrees each side of the center. Four 6-pounder rapid-fire guns are fitted on the broadside and one on the bridge. Electric hoists are used for supplying ammunition to these guns. The crew consists of 26 officers and 90 men, and quarters are also provided for 270 troops. The boat outfit consists of six units, two of which are steam launches. A large refrigerating plant and ample ventilating system are installed.

Activity in Warship Construction.

September 30, 1905, the warships building in British yards aggregated 42, of a total displacement of 264,310 tons. Of these ships 3 first-class battleships and 5 armored cruisers, aggregating 119,950 tons, are building in royal dock yards; 2 battleships and 4 cruisers, 12 destroyers and 12 submarines, aggregating 93,560 tons, are building for the British government in private yards; and 2 battleships for Japan and 2 large cruisers, aggregating 50,800 tons, are building also in private yards.

On the same date there were under construction in the United States for the United States Navy, 29 warships of an aggregate of 323,650 tons. This total includes 13 battleships, amounting to 196,740 tons; 9 armored cruisers, 114,460 tons; 3 scout cruisers, 11,250 tons; and 4 submarines, 1,200 tons.

The construction of ships of the larger classes for the eight leading naval powers, in order of naval importance, is thus summarized from the September *Proceedings of the United States Naval Institute:*

	Battleships.			Armored Cruisers.			Scouts.		
	No.	Tons.	Mean.	No.	Tons.	Mean.	No.	Tons.	Mean.
Great Britain	7	116 400	16,629	12	156,900	13,075	4	10,720	2,680
United States	13	196,740	15.134	9	114.460	12,718	3	11,250	3,750
France	6	89,190	14,865	6	78,582	13,097		.....	.....
Germany	6	84,800	14.133	4	42.000	10 500	9	29,200	3,244
Italy	4	50.500	12,625	2	19 290	9 645	..	......	.....
Japan	3	48,750	16,250	2	24 000	12 000	..	......	.....
Russia	5	71,776	14,355	*1	6 000	6 000	†3	20,250	6,750
Austria	3	31,800	10,600	1	7,400	7,400	..	......	.....
Total	47	689,956	14 637	36	442,632	12,295	16	51,170	3.198

* Coast defense. † Protected cruisers.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, report under date of November 10, 1905, the following percentage of completion of vessels building for the United States Navy:

			Oct. 1.	Nov. 1.
BATTLESHIPS.				
Virginia	19 knots.	Newport News Co	94.24	95.31
Nebraska	19 "	Moran Brothers Co	81.	82.
Georgia	19 "	Bath Iron Works	87.44	89.
New Jersey	19 "	Fore River Shipbuilding Co	90.1	92.1
Rhode Island	19 "	Fore River Shipbuilding Co	93.7	95.
Connecticut	18 "	Navy Yard, New York, N. Y.	89.39	91.3
Louisiana	18 "	Newport News Co	87.73	89.25
Vermont	18 "	Fore River Shipbuilding Co	63.8	65.8
Kansas	18 "	New York Shipbuilding Co	62 7	64.9
Minnesota	18 "	Newport News Co	73.86	75.41
Mississippi	17 "	Wm. Cramp & Sons	40.87	43.31
Idaho	17 "	Wm. Cramp & Sons	36.22	39.19
New Hampshire	18 "	New York Shipbuilding Co	20 4	25.
ARMORED CRUISERS.				
California	22 knots.	Union Iron Works	82.9	84.3
South Dakota	22 "	Union Iron Works	81 9	83.2
Tennessee	22 "	Wm. Cramp & Sons	86.08	87.8
Washington	22 "	New York Shipbuilding Co	85.8	87.9
North Carolina	22 "	Newport News Co	19.2	23.13
Montana	22 "	Newport News Co	16.81	19.21
SEMI-ARMORED CRUISERS.				
St. Louis	22 knots.	Neafie & Levy Co	79.69	81.28
Milwaukee	22 "	Union Iron Works	82.	84.01
SCOUT CRUISERS.				
Chester	24 knots.	Bath Iron Works	6.11	9.
Birmingham	24 "	Fore River Shipbuilding Co	9.3	12.6
Salem	24 "	Fore River Shipbuilding Co	8.2	12 3
SUBMARINE TORPEDO BOATS.				
Submarine No. 9	....	Fore River Shipbuilding Co	25.4	30.6
" " 10	....	Fore River Shipbuilding Co	21.1	29.
" " 11	....	Fore River Shipbuilding Co	23.6	29.3
" " 12	....	Fore River Shipbuilding Co	23.1	25.

The Fifty-second meeting of the American Society of Mechanical Engineers will be held during the first week in December, beginning with Tuesday evening, December 5, and ending on Friday morning. Papers will be presented on Thursday and Friday mornings, and the usual reception will occur at Sherry's Thursday evening. The remaining sessions will be devoted to lectures and business. The sessions will be held at 44 West 27th street, except that of Wednesday morning, which will occur in the main saloon of the steamship *Amerika,* at Hoboken.

Extract from a Letter to Marine Engineering from New Orleans, Dated October 27, 1905:

Yesterday President Roosevelt made a trip down the river front on the *Comus.* I hope his attention was called to the fact that among the many ships loading here, the British, Austrian, Spanish, Italian and German flags were in evidence. The *Missouri* was the only American ship loaded for a foreign port.

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands, in New York, not later than the 10th of the month, and in London, for the English edition, not later than the 20th, to insure the carrying out of such instructions in the issue of the month following.

The edition of the December issue of Marine Engineering comprises 8,250 *copies. We have no free list, accept no return copies and issue only enough to supply the regular demand, so that the* 8,250 *copies represent legitimate circulation.*

United States merchant marine, 1805...	1,140,367 tons
United States merchant marine, 1861...	5,539,813 tons
United States merchant marine, 1905*..	873,028 tons
Great Britain merchant marine, 1861...	5,195,217 tons
Great Britain merchant marine, 1905...	17,009,720 tons

Comment is superfluous.

*In foreign service.

Our English Edition.

Beginning with our January number, Marine Engineering will be published simultaneously in London and New York. This extension of our business is a result of the demand from not only all parts of the British Empire, but the continent of Europe as well, which makes it necessary for us to make our London office a regular publication office. We wish to announce that all advertisements appearing in the American edition will be published also in the English edition, and *vice versa.*

Convention Notes.

The annual convention of the Society of Naval Architects and Marine Engineers, which took place during the third week in November, contained an unusually interesting and well-balanced series of papers which might be summarized somewhat as follows:

Three papers on propellers and propulsion; six papers on warships, covering design and construction as well as trial trips; two papers on steam turbines; four papers on yachts and launches; one each on the strength of ships, troubles with boilers, and ventilating-fan experiments.

The two papers upon marine steam turbines have been rendered very timely by the great impetus which has been given to the development of that method of propulsion during the past year, not only in this country but, and in greater measure, abroad. In the United States there has been constructed and put into service up to date only one vessel propelled by the steam turbine, and this was simply experimental. There are now under construction, however, a considerable number of ships for both mercantile service and the United States Navy, which are to be propelled by this new motor. These ships cover a wide range of application, from high-speed naval scouts and fast coastwise passenger steamers to large passenger and freight steamers of medium speed and great carrying capacity; and it is confidently expected that the results obtained from the use of the turbines in these ships will lead to their immensely greater application in subsequent constructions. As we are going to press, news is received that the Cunard liner *Carmania,* propelled by turbines, made a speed over the measured mile of more than 20 knots, and a continuous speed for six hours of upward of 19.5 knots. This is safely in excess of the speed developed by her sister ship *Caronia,* propelled by quadruple-expansion vertical marine engines of the usual reciprocating kind. The speed of the *Caronia* on the measured mile was 19.62 knots, and a little more than 19 knots was maintained on the long-distance run.

The address of the president called attention in no uncertain terms to the condition of our deep-sea merchant marine, and pointed out the great differences between the conditions of the shipbuilders on the great lakes and those on the Atlantic and Pacific coasts. He quoted from the report of the Merchant Marine Commission, and made an eloquent plea for the restoration of the American merchant marine to its logical and legitimate position upon the high seas.

This idea was entered into more fully by the Honorable Jacob H. Gallinger, United States Senator from New Hampshire, in an address delivered at the annual banquet of the society, at the close of the convention. Senator Gallinger pointed out the fact that the method of obtaining relief from the situation which now oppresses both shipbuilder and shipowner must of necessity take the course of some assistance from the national government, supplemented, it may be, by additional assistance from the states and municipalities most directly interested in the problem, and to be most greatly benefited by its satisfactory solution. He also pointed out the fact that such assistance as the national government was called upon to give in the bill presented by the Merchant Marine Commission was not by any means the financial burden which has been generally supposed to be the case. It is specifically provided that in no year shall the total amount exceed nine million dollars, and it is estimated that for the first year it would be only slightly in excess of one million, and for the second year about two millions; these amounts being in each case the excess payment over and above increased tonnage dues collected from ships of all nations. It may be here remarked that the nine million dollars above mentioned is the gross outlay, and that its net effect upon the finances of the nation would be much decreased by the application of these tonnage dues.

He called attention to the fact that one of our great metropolitan newspapers had come out the previous Saturday (November 11, 1905), with an editorial entitled "Plain Subsidy," and we cannot do better than quote *in toto* this editorial from the *Sun:*

> In the course of human events the word subsidy has lost the unpleasant sound it used to have to American ears.
>
> A month ago to-morrow the American Bankers' Association, a conclave of gentlemen not directly interested in the profits of maritime traffic, but tremendously concerned for the prosperity of this nation as a whole, declared boldly and squarely and honorably and finely its approval of the ship-subsidy measure that has appealed in vain to Congress for more years than it amuses us to count.
>
> The bankers did not blink or balk at the word subsidy. They sought no periphrase. They went straight at the gist of the question and couched their resolution in language of a directness and emphasis that must have gladdened the ever patriotic and still youthful heart of the Hon. William Pitt Frye of Maine.
>
> We believe the country is coming to the conclusion reached years ago by that devoted friend of the American merchant marine, and by other far-sighted advocates of the only efficient or available measure for the restoration of the flag to its old place in the sea-carrying business of the world's commerce. The bankers have got there now. Everybody will get there who pursues faithfully and without prejudice the same course of disinterested reasoning.
>
> What an opportunity for the Fifty-ninth Congress to win immortal glory by the legislation that shall at last re-create the American merchant marine and put it at the front for the next half century!
>
> What an opportunity for the leader of American progress and the chief representative of an expansive national destiny to clinch the matter by a single word uttered in his next message with his accustomed perception of the psychological moment!
>
> Subsidy—just plain subsidy.

That the trade between the United States and Europe, both in passengers and in freight, offers exceptional inducements to those who can operate ships at the low rate of expense possible to our English, French and German maritime competitors is amply evidenced in the fact that each nation is at present constructing ships of the largest size designed exclusively for this service. Some of these ships are of very high speed, while others are of the very popular and comfortable "intermediate" type.

Not to mention numbers of ships of 12,000 tons or under which have been put into service by our competitors during the past year or two, we can list ten ships, each of 15,000 tons and upward, three of which have been placed in the North Atlantic service between Europe and the United States during the present year, while all of the remainder but two will be placed in that service during 1906, and the last two in 1907. Four of these ships are German, of which two belong to the Hamburg-American line and two to the North German Lloyd. The former are respectively, the *Amerika*, 22,724 tons, and the *Kaiserin Auguste Victoria,* 25,000 tons, both being intermediates of the most luxurious type. The two North German Lloyd steamers are the *Washington,* 17,000 tons, an intermediate, and the *Prinzess Imperial Cecilie,* 19,500 tons, which is virtually a sister ship to the *Kaiser Wilhelm II,* and of very high speed. Five English ships are included in the list, of which four belong to the Cunard line, and one, the *Adriatic,* 24,000 tons, is a sister to the big intermediate *Baltic* of the White Star line. The four Cunard ships are the *Caronia* and *Carmania* of 19,593 tons each, and the two mammoth flyers of 25,000 tons and 25 knots speed. The single French contribution to this magnificent array of ships is *La Provence,* 15,000 tons, of the Compagnie Générale Transatlantique, which is to reach the United States some time during the coming year. The ten ships above listed aggregate 202,410 gross tons, or an average of 20,241 tons each. This average is larger than any ship in existence in the year 1900, and shows not only the great increase which has taken place in the size of ships since that period, but also the fact that these large ships are very popular, relatively economical to operate, and extremely valuable not only to their owners, from the great returns made, but to the governments under which they are operated because of the possibility of their being used, if necessary, in connection with war service, as transports if they are of the intermediate type, and as scouts when they possess the high speed of four of the examples above quoted.

The mere fact that not a single American ship is being built or is contemplated for this service—that not a single ship of any importance has been built in American yards for North Atlantic service since the *Finland* and *Kroonland* of 12,760 tons were turned out at Philadelphia in 1902—serves as a sad commentary when viewed in connection with the tremendous and wonderfully valuable contribution to that trade represented by the ten ships above mentioned. It is humiliating to Americans to have to recognize this fact.

ABSTRACTS FROM RULES AND REGULATIONS OF THE GREAT LAKES REGISTER.

EDITION OF 1904.

ARRANGED BY HARRISON S. TAFT.

(Continued.)

18. Shaft Tunnels.

1. They must be built of steel or iron. When worked in connection with an inner bottom in the cargo space, they are to be of at least 15 pounds plating. Said tunnel is to be caulked watertight.

2. The stiffeners are to be of the same scantling as the reverse bars and be spaced not more than 2 frame spaces apart.

3. Under cargo hatches the plates are to be worked double.

4. There shall be a watertight door in the bulkhead at the forward end of said tunnel; same to work from the deck above the load water-line.

5. There shall be a stuffing box to the shaft where it passes through the bulkhead at the forward end of the tunnel.

6. There shall be a well at the aftermost frame space of said tunnel.

19. Shell Plating.

1. All shell plates except those at the extreme ends of ships should be at least 6 frame spaces in length. For all practical purposes the width of the side and bottom plates can be 1-4 of their length. If desired the width of the inside strakes can be from 10 to 15 per cent. more than the outside strakes. Butts of adjoining strakes should have at least a two-frame space shift from each other.

2. The midship weight is to extend for 1-2 length amidships. Forward and aft of said 1-2 length the weight of the plating can gradually be reduced as noted in Table 5. When intended for winter work the weight of midship plating should be carried all the way to the stem. Adjoining plates of the same strake should not differ in weight by more than 10 per cent. When the machinery is located aft the full midship weight must be maintained to after part of the machinery space.

3. Single-bottom vessels are to have their garboards, bottom, and bilge strakes 12 per cent. heavier than when a double bottom is worked.

4. No reduction from midship weight will be allowed on the boss plates of single-screw vessels or on the strake below them.

5. Sheer Strake.

(*a*) When the machinery is located aft the midship weight of said strake is to extend for 2-3 the vessel's length forward from the after end of the machinery space.

(*b*) When a sheer strake extends above the gunwale bar to such a height as to require two rows of rivets, a butt strap should be worked on the inside of said strake, extending from the stringer plate to the top of said sheer strake when double straps are used; the gunwale bar being joggled around said strap. When a single strap is used it is to be worked on the outside of said strake.

(*c*) When a sheer strake is cut for a port door or has large dead lights located in it, it must be strengthened at said points.

6. Steel Tow Barges.

The following reductions from the tabulated midship weights will be allowed in steel tow barges: side plating, 5 per cent.; bilge strakes and garboards, 8 per cent.; sheer strakes, 10 per cent.

7. Bulwarks.

Weight of bulwark plating should be in proportion to its depth, but it should not be of less than 10 pounds. A stiffening angle should be riveted to its upper edge, said angle being bracketed to the bulkheads at the end of a poop or forecastle deck. The bulwarks should be well braced by stanchions, having a sectional area equal to that of the reverse bars. Said stanchions to be spaced not more than 4 feet apart.

8. The awning-deck sheer strake should be 35 per cent. heavier than the side plating next below it.

9. In raised quarter- and poop-deck vessels no reduction will be allowed in the upper-deck sheer strake in the after end of said vessels. (See section No. 33.)

TABLE 5.—REDUCTIONS IN SHELL PLATING AT ENDS.

Weight of Plating for ½ length Amidships. Lbs.	13	14	15 to 23	24 to 25	26 to 28	29 to 35	36 to 40
Reductions for first twelfth at ends. Lbs.	2	2	3	4	5	6	7
" " second " " " "	1	2	2	2	3	4	5
" " third " " " "	1	1	1	1	2	2	2

Reductions to be figured from midship weights.

20. Butt Straps.

1. Double butt straps must be fitted to floors; center-line keelsons; sheer strakes; bilge strakes; stringers; tie plates; bottom longitudinals; and all other parts where possible. (See Table 8.)

2. When, by Table 8, double straps are fitted to the sheer strake and stringer plates amidships, single straps may be fitted to said plates at the ends.

3. When the edges of the butt straps are beveled their width must be increased by the amount of bevelling.

4. The transverse seam straps of the tank-top plating should be 15 per cent. larger in sectional area than the straps of the longitudinal seams of said plating.

5. When double straps are fitted to the sheer strake the outside one is to extend to the top of said strake in one length, the inside one stopping at the under side of the deck stringer.

6. Butt straps should be fitted to the butts of all doubling plates.

7. All bosom pieces to the center line, side keelson, or bottom longitudinal angles, or bulb angle bars, must be at least 2 feet long.

8. For further details of butt straps see Tables 7 and 8.

TABLE 6.—WEIGHT OF BUTT STRAPS. LBS.

Weight of plate in lbs.	10	12½	15	17½	20	22½	25	27½	30	32½	35	37½	40
Single straps. Double and treble riveted	12	15	18	21	24	27	30	33	36	39	42	45	48
Double straps. Double, treble or quadruple riveted — Inside straps	..	..	10	12	13½	15	16½	18	20	22	24	25½	26½
Double straps. Double, treble or quadruple riveted — Outside straps	..	..	11	13	14½	16½	18	19½	22	24	26	27½	28½

The weight of outside straps of double butt straps is for those with countersunk rivet holes. When the outside straps are not countersunk they may be of the same weight as the inside straps.

21. Riveting.

1. The system of riveting adopted for the longitudinal seams amidships must be continued all fore-and-aft to the ends of the ship; said seams of the shell plating being chain riveted.

2. When the longitudinal seams of the shell plating amidships are treble riveted, double riveting may be used at the ends.

When said midship seams are quadruple riveted, treble riveting may be used at the ends.

3. When, by Tables 8 and 9, treble riveting is called for amidships, double riveting may be used at the ends. When said tables call for quadruple riveting amidships, treble riveting may be used at the ends.

4. When, by Table 8, the butt straps of the shell plating are to be quadruple riveted and the frame spacing is 24 inches, the diameter of the rivets need not exceed 1 inch.

5. Doubling plates should be well riveted together on their edges and have extra frame rivets.

6. Countersinks of all shell plating, stringers, and deck plating should extend through the plates 3-4 of their thickness.

7. Rudder rivets are to be of the same size as those used in the bottom plating amidships.

8. Beam knees should be double riveted to both the beam and the frame.

9. Bosom pieces at the butts of the reverse bars are to have 3 rivets in each flange on each side of said butts spaced as per frame rivets.

10. Bosom pieces at the butts of continuous keelson bars are to have three rivets spaced 5 diameters apart on each side of said butts.

11. THE FOLLOWING TO BE SINGLE RIVETED:

(*a*) Longitudinal seams of the deck plating.

(*b*) Butts of all deck plating at ends of ship.

(*c*) Longitudinal seams of the tank-top plating, except those of the center-line strake.

(*d*) All butts of the tank-top plating outside of the engine room, except those of the center line and margin strakes.

(*e*) Longitudinal seams of the bottom and bilge plating when under 15 pounds.

(*f*) Longitudinal seams of the side plating when of 17 1-2 pounds or less.

12. THE FOLLOWING TO BE DOUBLE RIVETED:

(*a*) All butts of the shell plating, sheer strakes, stringers, and tie plates, to be at least double riveted throughout. Also the side plating of an awning-, poop-, or quarter-deck vessel.

(*b*) Butts of all plated decks between hatchways.

(*c*) Butts of the lower-deck plating between the stringer plates and hatchways throughout.

(*d*) Longitudinal seams of the bottom and bilge plating when of 15 pounds and above.

(*e*) Longitudinal seams of the side plating when over 17 1-2 pounds.

(*f*) Transverse seams of the tank-top plating when of 20 pounds or over.

(*g*) Inner edge of the upper-deck stringer plate when the vessel's length exceeds 400 feet.

(*h*) Longitudinal seams of the sheer strake and flat-plate keel when of 15 pounds or over.

(*i*) Longitudinal seams of the shell plating between the two sheer strakes in spar-deck vessels.

(*j*) Lower longitudinal seam of the awning-deck sheer strake in awning-, poop-, and quarter-deck vessels.

(*k*) Longitudinal seams of the tank-top center-line strake.

(*l*) Tank-top margin plate when flanged to the shell plating.

(*m*) Inner edge of the stringer plate when the vessel's length is 350 feet or above and the hatch width is not over 1-3 of the vessel's beam.

(*n*) Butts of the upper-deck plating between the stringer plate and hatchways at ends, when treble riveted amidships.

(*o*) Knee brackets to the beams.

13. THE FOLLOWING TO BE TREBLE RIVETED.

(*a*) Butt straps of the upper-deck plating between the stringer plates and the hatchways for 1-2 length amidships, when the upper-deck stringer butts are treble riveted throughout as set forth in Table 8.

(*b*) Butts of all floor plates.

(*c*) Butts of all flat-plate keels (at least).

(*d*) Butts of all garboards (at least).

(*e*) Bilge brackets connected to channel floors by double butt straps.

(*f*) Butts of the awning-deck sheer strakes and stringer plates for 3-4 vessel's length amidships, when said deck extends the full length of the vessel.

(*g*) The three aftermost butt straps of each strake of the shell plating between the keel and the deep load water-line in vessels over 168 feet in length, with their machinery fitted aft.

14. The Following to be Quadruple Riveted.

(*a*) Overlapped butts of floor plates when butts of said floors are all in line on the same side of the ship (having four full rows).

(*b*) Bilge brackets which are lapped on to channel floors (having four full rows).

15. For further details of riveting see Tables 7, 8, and 9.

22. Double Bottoms.

1. When solid or bracket floors are not fitted, bracket plates are to be fitted to the center vertical keelson on every frame, having double clips to same. Said brackets are to be securely riveted to the frames or floors and be secured to the middle-line strake of the tank-top plating with a single clip. The diagonal edge of said brackets should be flanged.

2. The width of the brackets on the floors should be twice the depth of a channel floor or 1 1-2 times the depth of a plate floor, and should taper to half of said width at the tank top.

3. The side longitudinals on top of floors, or when worked in connection with cellular bottoms, should be spaced not over 4 feet 6 inches apart. They should be worked continuously through all watertight floor with watertight staple work at same. They may be worked intercostally throughout the engine-room space.

4. (*a*) In steamers of 250 feet length intercostal plates or channel chocks should be worked between the floors in way of one of the side longitudinals. When said length exceeds 300 feet said channel chocks or intercostal plates should be worked in way of all the longitudinals.

(*b*) Barges and sailing vessels are to have said intercostal plates or channel chocks as follows:

Length of Ship.	Arrangement of Chocks.
300 feet, under 375 feet.	In way of one side longitudinal.
Over 375 " " 425 "	" " " two side "
425 and above.	" " " all " "

5. There shall be a single angle bar at the top and bottom edges of said longitudinals worked continuously. There shall be a vertical stiffener at each floor.

6. Under the boiler room solid manhole plate floors are to be fitted to alternate frames, but to every frame under the engine room.

7. The center-line keelson is to be caulked watertight. It should be increased in weight by 10 per cent. within the machinery space.

8. The bilge brackets on the underside of the margin plate are to be of two sizes, the larger one being fitted at the web frames.

9. A drainage well should be fitted at the after end of the engine compartment.

10. When a cellular bottom is adopted, solid manhole plate floors or bracket plate floors must be fitted intercostally between the continuous side girders (see 3, above), on alternate frames. The size of said manholes to be such as to leave a clear plate surface all around the hole equal to 2 1-2 times the depth of the standing flange of the angle frame.

11. In cellular bottoms the intercostal floor plates or brackets may be 12 per cent. lighter than otherwise.

23. Tank Top.

1. When the machinery is fitted aft, as typical with bulk freight vessels of the Great Lakes, the tank top should extend from the forward collision bulkhead to the bulkhead at the forward end of the machinery space. It may also be worked throughout the machinery space.

2. The plating, except the center line and margin strakes, may be worked longitudinally or transversely, as desired; all with flush seams. The center line and margin strakes must be worked longitudinally.

3. When no wood ceiling is fitted on top of the tank-top plating said plating (except the margin and middle line plates) should be of the same thickness as the middle-line strake; all with flush seams.

4. The tank-top bed plate in the engine room is to be made extra heavy as specified, and be well supported by extra solid plate floors and intercostal keelsons.

5. Manholes should be so arranged in the tank top as to provide of ready access to all parts of the inner bottom.

6. The margin plates may be connected to the shell plating by a suitable flange on said plates when the frames are cut at the tank top. Or a continuous angle bar may be worked in lieu of said flange.

7. The tank-top frame brackets must have a flanged diagonal edge or have a small angle-bar clip on same for securing the bilge ceiling to said brackets. The bilge ceiling must be grain tight.

8. The tank-top frame brackets are to be of the same weight as the plates of the side longitudinals, and have double clips of reverse-bar size connecting them to the margin plates.

9. The watertightness of the tank top is to be tested by a head of water equal to that of the deep load water-line.

10. All water-ballast tanks and inner-bottom compartments are to have at least one sounding pipe 1 1-2 inches in diameter, and two air pipes 2 1-2 inches in diameter.

24. Boiler Enclosures.

They must be of steel. When built above or below the weather deck the plating of same must be of at least 8 pounds for steel, but 10 pounds for iron, properly stiffened. Doors are to be of not less than 10 pounds plating. The tops of all door sills are to be of at least 12 inches above the deck. When said enclosures are fitted to a wood coaming the plating is to be connected to said coaming by a 4- by 8-inch angle bar with its shortest leg vertical.

25. Hatchways and Deck Openings.

1. The width athwartships of the hatches, as used on bulk freight vessels of the Great Lakes, should not exceed 2-3 the vessel's beam, or be over 8 feet fore-and-aft, being spaced 24 feet center to center.
2. The hatch coamings of the upper deck should stand not less than 8 inches above the deck, being of bulb angle.
3. Suitable strong backs should be provided to support the hatch covers.
4. When the fore-and-aft length of a hatch or deck opening exceeds 12 feet, shifting beams, spaced not over 8 feet apart, must be provided. When said length is 18 feet the end beams of said hatch must be made 1-16-inch thicker than otherwise.
5. The fore-and-aft coamings at side of hatches that are 6 but under 9 feet in length must have suitable stanchions, and web frames to support same.
6. Companionways on exposed decks are to have coaming plates of the same height as the depth of the deck beams to which they are attached.
7. Coamings of scuttles to cargo holes located on the upper deck are to be of the same depth as those of the cargo hatches.
8. Hatch Covers. They may be of pine 2 inches thick with oak carlings; or built in sections of 3- by 3 1-2-inch pine edge bolted and grooved at each end to fit over the bulb coamings. They must be provided with tarpaulins and suitable batterns for holding them down.

26. Wood Decks, Ceilings, Etc.

1. When a wooden deck is fitted, longitudinal and diagonal tie plates must be fitted to the deck beams with the deck planking scored over same. The deck planking is to be of white, yellow, or Southern pitch pine.
2. On exposed decks the width of the deck planks should not exceed 6 inches, with single fastenings. When the width of the deck planking exceeds 6 inches double fastenings are to be used.
3. The fastenings shall consist of galvanized screw bolts and nuts, the head of the bolts being let into the planking, bedded in wax and white lead, with a deck plug over the bolt head.
4. When laid on a steel deck the thickness of the deck planking may be reduced by 1-2 inch from the tabular requirements, but to be not less than 2 1-2 inches thick.
5. The steel deck is to be well coated with oil or other approved substance before the deck planking is laid thereupon.
6. Wooden decks must not be worked in way of the engine, boiler, or coal-bunker spaces.
7. All steel and wood decks are to be properly caulked and made watertight.
8. Single-bottom vessels should be close ceiled to the upper turn of the bilge and spar ceiled on the sides. Said ceiling on the sides is to be secured to the reverse frames by a bolt and nut. A ceiling should be laid on the tank top under hatches. In bulk freight vessels no side ceiling will be required.
9. A stiff coat of Portland cement wash is recommended for peak tanks, and the interior of double bottoms. Also for inside of bottom plating, frames, floors, and rivets to the upper turn of the bilge in single-bottom vessels.
10. All other parts of the steel work are to have three coats of good oil paint.

27. Valves; Drains; Scuppers, and Freeing Ports.

1. A substantial strainer should be fitted on the outside of the shell at all sea connections.
2. A suitable stuffing box should be fitted to all pipes where they pass through a watertight floor or bulkhead.
3. The suction boxes to all ballast tanks should be located at the aftermost part of said tanks, close to the center line.
4. No valves or cocks shall be fitted to the forward collision bulkhead, the peak being fitted with a syphon or pump.
5. Suitable means should be provided for draining the tank top and boiler deck.
6. The suction pipe to the fore-and-aft peaks and to the tunnel well should be not less than 2 inches inside diameter when gross tonnage is under 500, but 2 1-2 inches when said tonnage is 500 or above.
7. Scuppers are to be fitted to all decks, those to the lower decks leading to the bilge or water bottoms. Scuppers to the upper deck are to lead to openings in the top side plating below the main sheer strake.
8. When the bulwarks exceed 30 inches in height, and in all well-deck type of vessels, the total area of the freeing ports is to equal 1 square foot for each 30 superficial square foot of bulwarks for 2-3 length amidships. In all other vessels the total area is to equal 1 square foot for each 45 superficial square foot of bulwarks for 2-3 length amidships.
9. In tow barges the manifold box is to be placed in a separate watertight compartment extending to the main deck.

28. Rudders.

1. Pintles should not be spaced over 5 feet apart. They should be fitted independently in the frame.
2. The plating is to be from 10 to 17 1-2 pounds, with wood filling between the plates. In high-speed steamers the plates should be double riveted to the frame.
3. There shall be a stuffing box on top of the transom floor.

4. The rudder must be arranged so that it can be unshipped while the vessel is afloat.

5. Balanced Rudders.

(*a*) The plating is to be not under 10 or over 20 pounds, with solid wood filling between the plates. In steamers with a speed of over 14 miles an hour the plates are to be double riveted to the frame.

(*b*) The foot pintle is to be in diameter 1-2 the tabulated diameter of the rudder's head.

(*c*) With the present style of rudders used on the Great Lakes the best results are obtained when 20 per cent. of the width of the blade is forward of the rudder post.

29. Spar=Deck Vessels.

1. When the deck next below the upper deck is worked continuously and is fully laid, the side plating between the upper-deck sheer strake and the second deck can be reduced by 15 per cent., provided the main sheer strake or shell strake in way of the second deck is increased by an amount equal to the above reduction.

2. There shall be a doubling plate to the sheer strake over the cargo port doors extending two frames fore-and-aft of the frames at the ends of said port.

30. Awning=Deck Vessels.

1. This class of vessels consist of those having a light superstructure built upon the upper deck for light goods or passenger purposes. In no case will said structure be permitted in single-deck vessels.

2. The deck next below the awning deck must be continuous and fully laid. The hatch coamings of this deck must be treated as if on an exposed or weather deck.

3. The side plating of the above structure must not be of less than 11 pounds, with no reduction at the ends.

4. The tie plates of the awning deck are to be the same as those for an upper deck.

5. Hatchways in the awning deck must not be over 1-3 the vessel's beam or over 10 feet in a fore-and-aft direction. When for any special reason it is necessary to make said fore-and-aft dimensions more than 10 feet stanchions must be fitted at the hatch corners.

6. When a wooden deck is laid on the awning deck it must be not less than 2 1-2 inches thick.

31. Shade Decks.

These decks shall consist of a light superstructure erected above the weather deck with open sides; adding no structural strength to the ship.

32. Raised Forecastle Deck.

1. The beams of said decks are to be located on alternate frames efficiently supported by stanchions.

2. When a wooden deck is used the thickness of same is not to be less than 2 1-2 inches.

3. A continuous side stringer is to be worked in the forecastle, midway between decks, ending in a breast hook.

4. The side plates for the raised forecastle should extend two frame spaces aft of said forecastle bulkhead. The plates covering the break should be made 20 per cent. heavier than their adjoining plates.

5. When the length of a raised forecastle exceeds 1-4 of the vessel's length the upper-deck sheer strake is to be made 50 per cent. and the stringer plate 20 per cent. heavier for a distance of some 20 feet at the break.

33. Poop and Raised Quarter Decks.

1. The bulkhead at the end of a poop or raised quarter deck should have vertical stiffeners spaced 30 inches apart, properly bracketed at top and bottom.

2. Horizontal bracket plates of the same weight as the bulkhead coaming plates are to be secured to the bulwarks and bulkhead plating midway between decks.

3. When wooden decks are laid a transverse tie plate should be worked on the bulkhead beams so as to provide a proper support for the stiffener bracket plates.

4. The side plates of the poop shall extend two frame spaces forward of the poop bulkhead. The plates covering the break shall be 20 per cent. heavier than their adjoining plates.

5. When the length of a poop deck exceeds 1-4 the vessel's length the upper-deck sheer strake is to be made 50 per cent. and the stringer plate 20 per cent. heavier for a distance of some 20 feet at the break.

6. When the combined length of a forecastle and poop or of a raised forecastle and quarter deck exceeds 40 per cent. of the vessel's length the upper-deck sheer strake is to be 20 per cent. heavier than otherwise between the forward and aft erections.

34. Sunken Windlass Deck.

1. The bulkhead at the aft end of a sunken windlass deck should be of the same thickness as the upper part of the collision bulkhead, with angle stiffeners spaced 30 inches apart on the after side. If the height of said bulkhead exceeds 4 feet there shall be a horizontal stiffener on the forward side, equal in section to the main frames.

2. No doors will be allowed in said bulkhead below the weather deck.

3. Said deck is to be made watertight and provided with suitable drains.

4. The chain pipes when possible should extend at least 6 inches above said deck plating.

35. General.

1. A suitable ladder is to be fitted to both peaks and to all cargo holds.

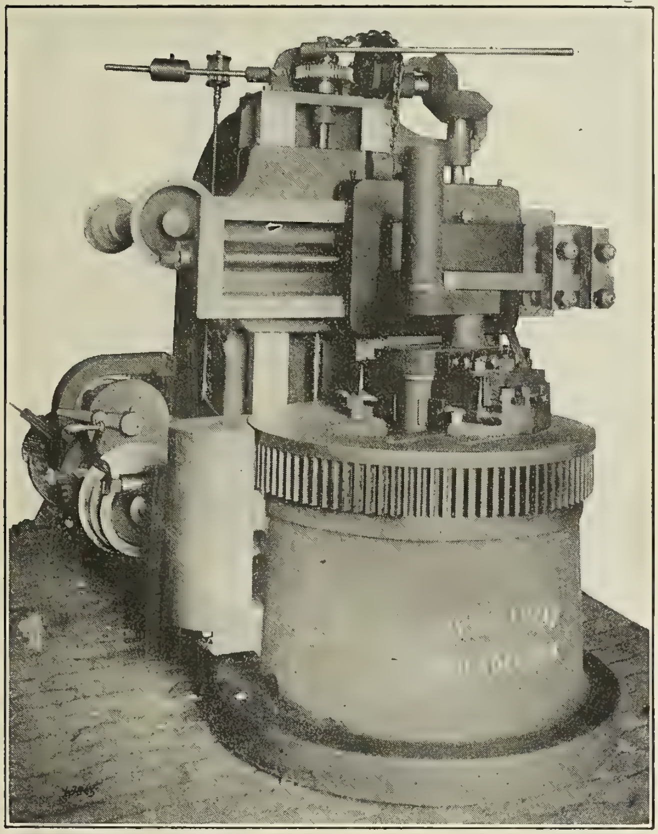
2. Any part of the "chains" that are worn to 1-4 of their original sectional area must be renewed.

3. Note. In view of the modern type of bulk freight "lake vessels," a number of the foregoing rules, etc., are somewhat of an obsolete nature.

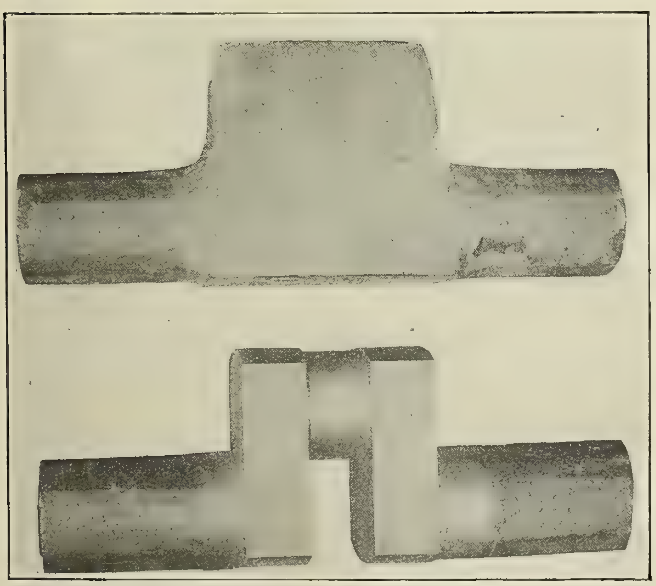
ENGINEERING SPECIALTIES.

A Crank-Shaft Forming Machine.

We illustrate herewith a machine designed by the Espen-Lucas Machine Works, of Philadelphia, for the purpose of forming crank shafts from rough ingots, and show also a photograph of one of the crank shafts compared with a rough ingot similar to that from which it was formed. A general method in manufacturing crank shafts heretofore in order to remove the large mass



of metal from the center of the forging has consisted in drilling holes across the web and then sawing through the holes and breaking out the material to be discarded. This resulted in forming a rough square pin. It was then necessary to center the pin and shaft and so balance the forging with jigs that the pin could



A BLANK AND THE MACHINED CRANK.

be turned up in a lathe. The present machine is designed to do away with this clumsy method by taking out the material from the throw, turning off the ends and sides, and finishing the outside of cheeks, and facing off the top and bottom of the crank. These operations for the crank shaft illustrated were accomplished in one hour and thirty minutes, the crank being held vertically in the machine to avoid the strains resulting from the alternate rise and fall of the weighty lump of the forging, which would have been existent had the crank been turned in a horizontal position.

The machine is furnished with a patent universal vise for roughing out crank shafts and a stationary vise for finishing, these vises being adjusted to different sizes of crank shafts. The machine illustrated can handle shafts with throws as high as 20 inches, and for the larger sizes uses a tool 2½ inches wide. Automatic feeds are fitted in all directions. The gears are of hammered crucible steel with bearings lined with bronze. The entire machine, which is extremely powerful, weighs about 20,000 pounds.

Gasoline-Propelled Canal Boats.

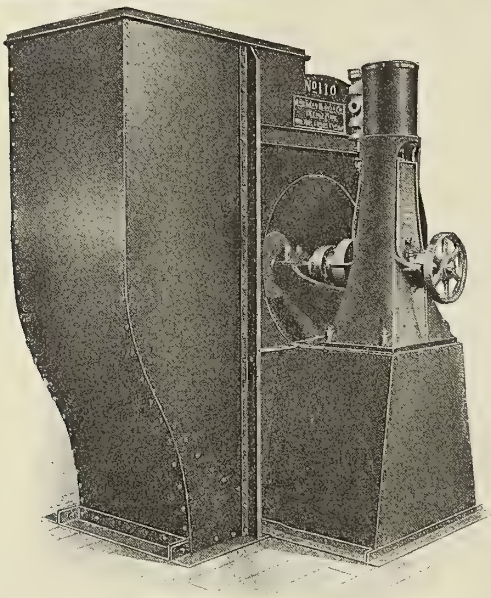
The boats shown in the reproduction are the property of the Ohio Boat Company. and are the result of an experiment tried a year ago. At that time one boat, the *Monitor,* was equipped with a 21-horsepower Clifton marine engine, and put in operation on the Miami and Erie Canal between Cincinnati and Lockland, O. This boat did not miss a trip in the entire year, except from such causes as ice, or breakages in the canal banks. The owners of the boat found the gasoline engine so superior to mules that they immediately built six more steel boats and equipped them with this same type of engine. These boats were recently put in operation and have been running steadily ever since.

One boat, which has a particularly long run, is equipped with a 28-horsepower engine, while the others have only 21 horsepower, These engines are very economical, the company reporting a great saving in operating expenses over the old mule-drawn boats. In addition to the greater economy, the saving in time is considerable. Where it formerly required twelve hours to make a trip, the gasoline boat makes it in five to six hours. The system of propulsion is known as the "Coen system." The boats have a tunnel built in the center, in which a propeller revolves. To keep the propeller fully covered, an air pump and stand pipe are employed. The engine operates the air pump and maintains a solid body of water about the propeller. The engines were furnished by the Clifton Motor Works, Cincinnati.

A New Blower Outfit.

Experience has shown that in handling hot gases with a fan, as in a plant producing induced draft for boilers, it is impossible to give the fan shaft a suitable bearing at the inlet side. A bearing here would necessarily be situated in the inlet area and would be constantly surrounded by hot flue gases. Much better results have been obtained by the use of an over-hung wheel, having in addition to the two engine bearings a bearing on the engine side of the fan, but none on the inlet side. The usual form of construction, that is, providing for a third bearing separate from the engine, has, however, given trouble from the fact that this bearing cannot readily be lined up with the two engine bearings.

A new method of construction which overcomes this trouble has all three journal boxes cast in the engine frame, and all can be bored with the same boring bar. It is thus impossible for them to be out of line. The fan bearing is water-cooled and ring-oiled. The bearing is supported by the engine bed and not by the housing of the fan, as would otherwise be the case. This simplifies the construction by doing away with the additional bracing usually found on fan housings.



The wheel is varied somewhat from the ordinary construction. In place of the usual three spiders is substituted one heavier one built of I-beams cast into the hub. The blades are braced upon each other. The wheel constructed in this manner has been shown to be fully as strong and rigid as the ordinary three-spider form. By the use of a single spider the necessity for more than one hub on the shaft is obviated. In this manner the load of the wheel is concentrated upon a comparatively short length of shaft.

The engine is of the enclosed type, oiled by a recently-devised pump which distributes copious streams of oil over all of the reciprocating and revolving parts, even lubricating the eccentric outside of the frame. Tests in actual practice have proved that it will run several months without re-oiling or adjustment.

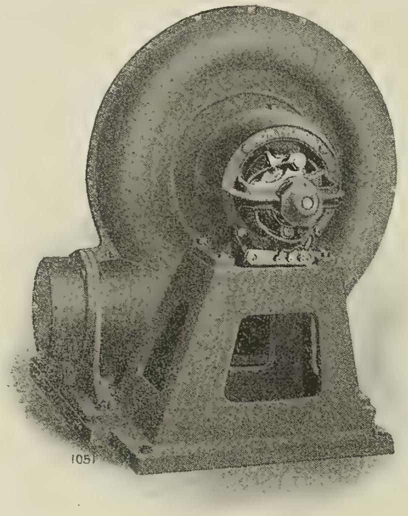
This outfit is manufactured by the American Blower Company, of Detroit, Mich., from whom further information and prices may be obtained.

Bowes Patent Hose Coupling.

For the purpose of joining two sections of hose for carrying compressed air from the source of supply to any pneumatic tools which may be using it, or for connecting such a hose to a stationary tap, the Cleveland (Ohio) Pneumatic Tool Company has placed upon the market a coupling which is very readily connected, and is so designed as to make a very tight joint under pressure. The sizes are largely interchangeable. The coupling is made in sizes from ¼ inch to 1½ inches.

Northern Electrical Blower Outfit.

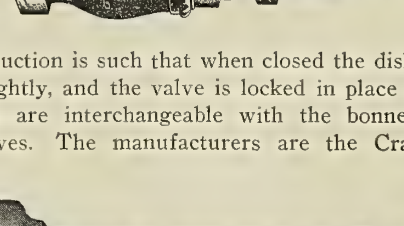
The illustration shows a direct-connected outfit consisting in a motor built by the Northern Electrical Manufacturing Company, of Madison, Wis., and a centrifugal blower or fan used to develop air pressure for the various purposes required on shipboard or in shipyards. The motor is of the spherical design and



very compact, with great capacity for bearing all sorts of hard usage. It is completely self-contained, and has been found to give very general satisfaction wherever used. It is built in a variety of sizes, with various speeds dependent partly upon the voltage for which it was designed and the work to which it is to be applied. The rated capacities run from 75 to 425 cubic feet of air per minute, at 1½ ounces pressure.

A New Quick-Opening, Self-Packing Steam Radiator Valve.

The self-packing feature precludes any possibility of these valves leaking at the stuffing boxes. By a special device the packing is automatically kept tight, and will last for years without renewal. The device is very simple, consisting only of a vulcanized washer, located in the top of stuffing box and kept in position by spring compression, which fully compensates for the wear on washer. These valves open and close by turning the lever handle one-half turn. The quick opening and closing feature will be appreciated by users.



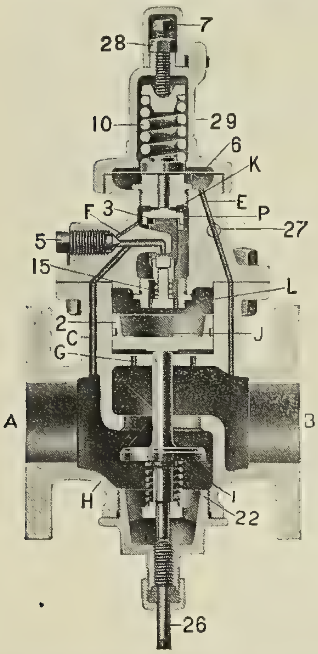
The construction is such that when closed the disks bear on the seats very tightly, and the valve is locked in place until released. The bonnets are interchangeable with the bonnets of regular radiator valves. The manufacturers are the Crane Company, Chicago.

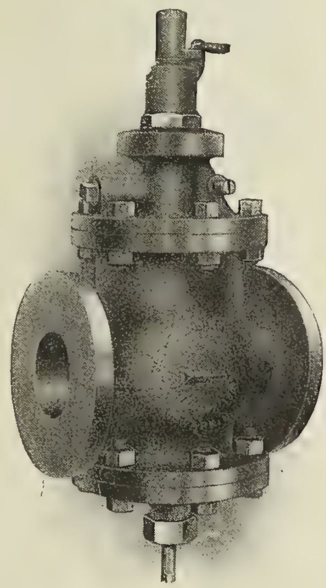
TESTS OF PRESSURE REGULATORS.

At the plant of the Foster Engineering Company, Newark, N. J., on October 26, were held a number of tests of pressure devices designed for various purposes.

First Test: Was of the new type *G* reducing valve, the object of which was to illustrate the delivery of steam at a constant pressure regardless of the variation in the volume of discharge, or increase or decrease of the initial pressure; to show that the valve would operate equally well in a horizontal, vertical, or inverted position or when inclined at any angle; and that the valve would close off dead tight when no steam was being delivered.

In demonstration the valve was first placed on a horizontal pipe in a vertical position. Steam was turned on with the initial pressure at 250 pounds and the valve set to deliver 30 pounds.





The variable volume of discharge was obtained by opening and closing at intervals four one-half inch (½") outlets connected in manifold to discharge pipe, steam first passing through a small receiving tank. During this test the delivery pressure did not vary one pound. It was then suggested that the receiver be taken off and a one and one-quarter inch (1¼") quick opening gate valve placed on line direct from outlet of regulator. In this test the quick opening valve was frequently opened and closed without showing a variation of delivery pressure exceeding two pounds. The valve was then inclined at different angles and then inverted, the results obtained in either case being the same as when upright. The initial pressure was then lowered and the delivery, with variable volume of discharge, remained constant until the initial pressure had fallen to 33 pounds, delivery being 30 pounds. The diaphragm was then removed while steam was passing through the valve, delivery pressure being 60 pounds and 30 pounds with the initial at 250 pounds. To remove the diaphragm screw 26 was adjusted to throttle the steam to the desired pressure, by-pass screw 5 opened and port screw 27 closed; tension of spring 10 was then released, when cap 29 was unscrewed and the diaphragm removed. The whole operation required less than five minutes. It was then suggested that all tension be taken off spring to see whether the valve would hold tight while delivering no steam. This was done and the gauge showed no pressure.

Second Test: The piston-actuated pump governor was tested to illustrate the maintaining of pressure by speed of pump. The variable volume of discharge test was obtained by manifold being connected from discharge of pump, with the result that the pump speeded up to maximum, discharge being maintained at the predetermined point—100 pounds.

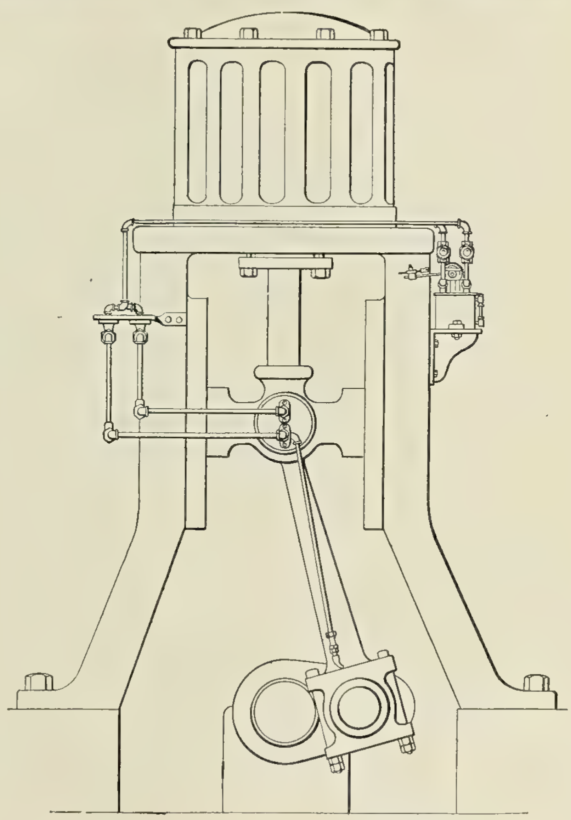
Third Test: This test was to illustrate the class *Y* reducing valve to reduce from high initial pressure—1,400 pounds and up—to low delivery, 140 pounds—for the purpose of expelling gases from guns after discharge. An eight-inch iron pipe twenty feet long was used to illustrate the effect of air admitted to inlet of pipe. Oily waste was placed in tube and ignited to produce smoke and flame. A quick opening gate valve was installed on the line to tube from outlet of reducing valve and opened suddenly to expel the gas and flame. The result of the test showed that the reducing valve maintained the delivery pressure as required, and the result was very satisfactory.

Fourth Test: This was of the combination valve installed on boiler, the object being to close down in case of a rupture in steam main. A quick opening gate valve was placed in the line and opened to the atmosphere, which gave the same practical result as of a break in the pipe. In this operation the automatic valve on the boiler closed instantly and shut off steam to line. The main valve was then closed by opening a small valve in emergency line, to illustrate emergency closing, with the same satisfactory result.

Fifth Test: This was to illustrate the automatic safety stop valve to be used in connection with steam lines whereby the rupture of one line will close valve and shut off steam from that particular line, without shutting down the whole plant. The same quick opening gate valve as in the combination valve test was used, with the result that the automatic safety stop valve instantly closed down.

Force-Feed Lubricating Pump.

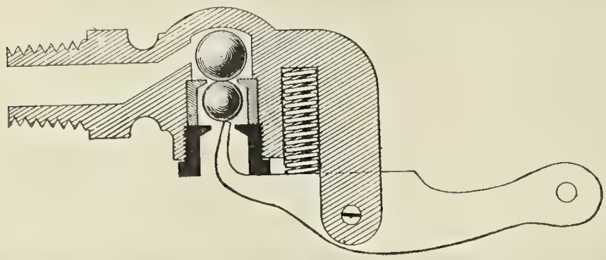
An oiling device for marine use is being manufactured by the Hills-McCanna Company, of 128 East Kinzie street, Chicago, Ill. The oil is distributed from a double pump so arranged as to get the driving motion from the crosshead, and swinging pipes are



arranged for lubricating both the crosshead pin and the crank pin. The conductors are of ¼-inch extra heavy pipe, and run from a bracket on the engine frame to an intermediate pivotal point and thence to the crosshead. At this point one pipe delivers oil to the crosshead pin, while the other, by means of an additional pivot, discharges it through another conductor along the length of connecting rod, and so to the crank pin.

A New Gauge Cock.

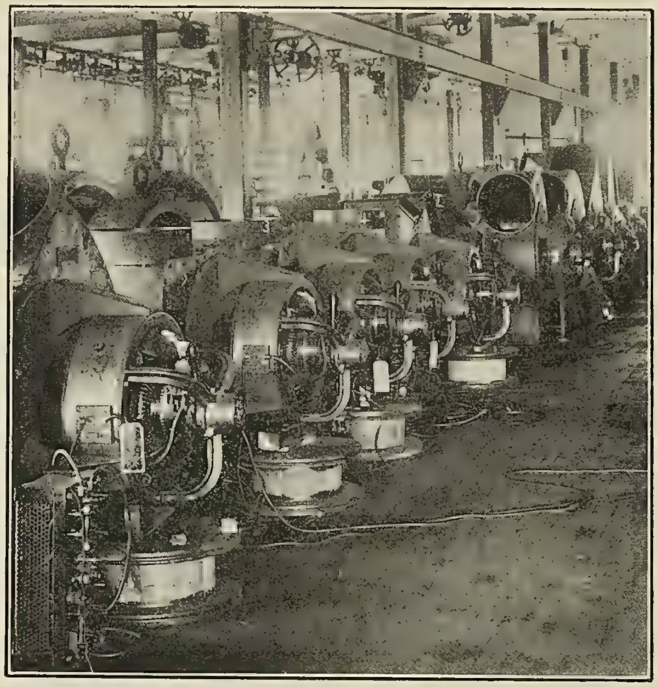
For the purpose of testing the level of water in a boiler, the Ætna gauge cock, which has just been placed upon the market by George W. Neff & Company, 42 Broadway, New York, N. Y., seems very well fitted. As shown in the illustration, the design is very simple, the action being the displacement of a steel ball



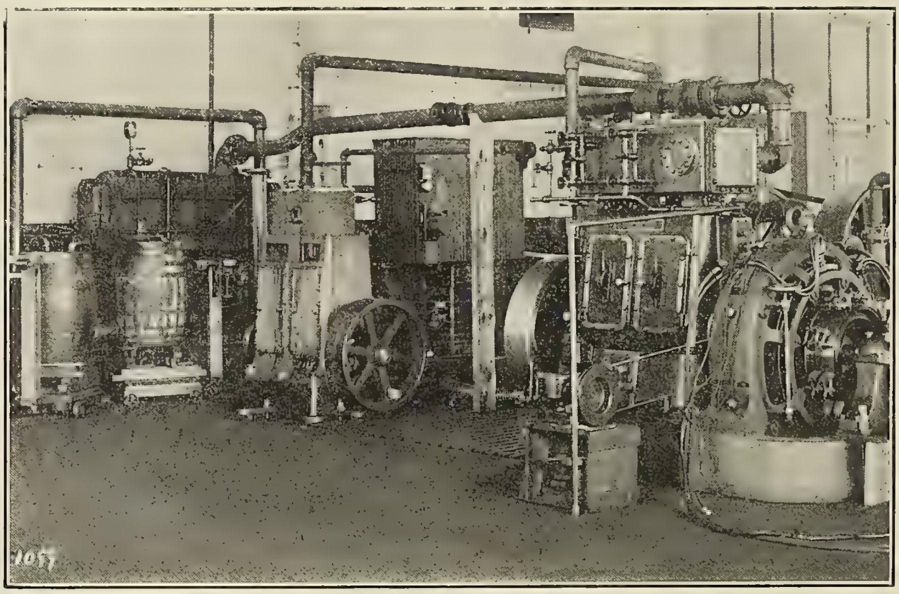
from its seat by means of another ball forced against it by a lever. This enables the steam to escape so long as the operator holds the lever in that position, but once released, the pressure of boiler steam forces the ball back upon its seat, and the auxiliary ball upon the auxiliary seat insures an absolutely tight valve. It is made in standard sizes, of hard phosphor bronze, with interchangeable parts.

The Sturtevant Testing Department.

In order to comply with the very rigid requirements of the United States Navy Department with regard to the performance of blowers, fans, and electric generating sets, the B. F. Sturtevant Company, of Hyde Park, Mass., has installed in its new plant a very complete outfit for testing the machinery as manufactured in order to determine its efficiency of operation, and to follow up and remedy any defects which may develop, as well as to obtain information leading to improvements in the various types of mechanism.



TESTING OF MOTOR-BLOWER SETS.



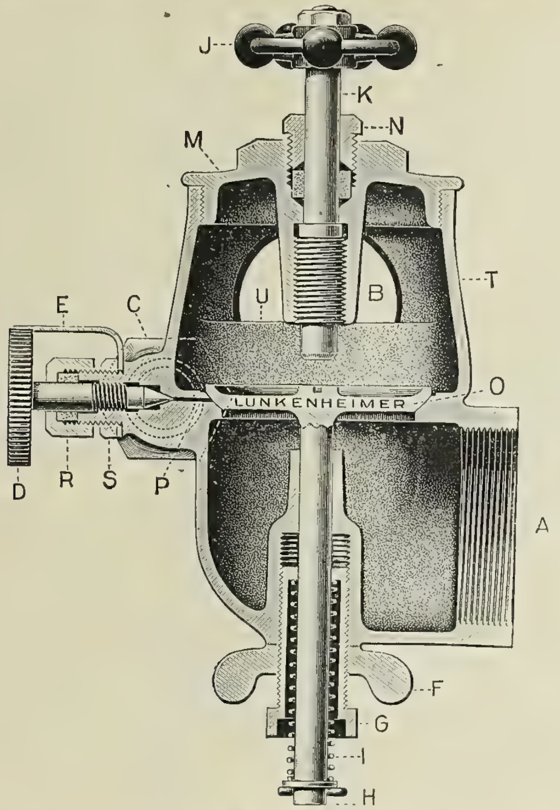
TESTING OF DIRECT-CONNECTED UNITS.

The testing department occupies parts of three floors of the building devoted to the manufacture of fans and heaters; the two upper sections being used for the testing of the lighter equipment connected with the operation of blowers and fans, while the large testing space on the first floor is used for electric-lighting sets. The testing plate measures about 30 feet by 60 feet, and is completely equipped with steam and electrical connections in such a way that engines may be run either condensing or non-condensing, and all sorts of tests made for determining power and efficiency, as well as for adjusting valves and for obtaining any sort of information which may be desired. Condensers and heaters are used in connection with the work, while the electrical part of the equipment is designed to absorb the power developed by the generators and make possible the determination of its amount. We present herewith two photographs showing respectively the fan-testing plant and the plant for testing direct-connected lighting sets.

An Improved Generator Valve.

An improved form of generator valve has lately been placed on the market by the Lunkenheimer Company, Cincinnati, which embodies a number of desirable and important features highly appreciated by users. The sectional view herewith clearly illustrates the construction of the valve. One of its principal features is the easy regulation of the spring which holds the disk to its seat. This regulation can be easily accomplished (while the engine is running), and without in any way interfering with the proper operation of the valve.

It has been found that gasoline engines work best with the generator valve-disk spring set at some particular tension; but as this particular tension cannot be ascertained except by trial, when the engine is in operation, it is necessary that provision be made

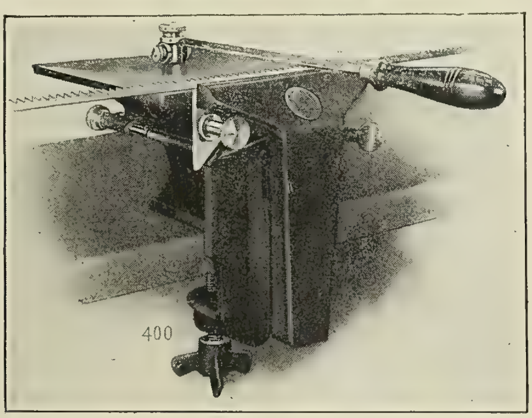


for the easy adjustment of the spring while the engine is running, which important feature will be found in this improved form of generator valve. The lift of the disk, and consequently the speed of the engine, is regulated by means of the stem *K* operated by wheel *J*.

The valves are made of a very high grade of bronze composition, and the metal is so distributed about the valve that those parts subjected to the greatest strain are made heavier in proportion. Owing to the oxydizing effect of gasoline on iron or steel, these materials are entirely eliminated.

A New Band Saw Filer.

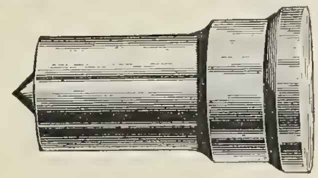
Joiners and boat builders will be interested in a new device just issued by the New Britain (Conn.) Machine Company (Dept. M), which is designed to obtain the best results in filing saws without any possibility of leaving a rough edge on the tooth. The work is done by hand, and the adjustment is such that a splendid job is possible. The outfit may be attached to any bench not over 2 inches in thickness, and weighs complete 14 pounds.



The file is guided mechanically in a horizontal direction, and also prevented from turning in the hand. These guided movements determine the contour of the tooth, remove any tendency to variations in the shape of same and limit the personal skill required.

New Process Punches.

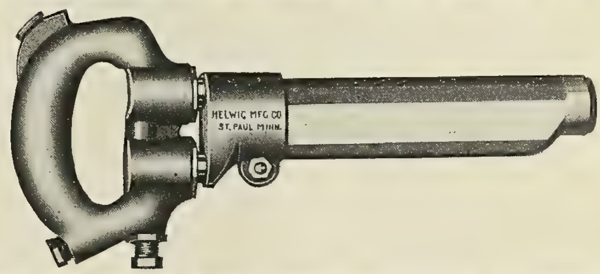
By the use of high grade steel especially adapted for punches, and an exact method of tempering, the George F. Marchant Company, of Lake and Elizabeth streets, Chicago, claim to make every punch absolutely uniform in quality. The punch illus-



trated has been made according to the above method, and it is claimed that a great gain is effected by their use because of their avoiding the loss of time required for changing defective punches in the presses.

The Helwig Pneumatic Hammer.

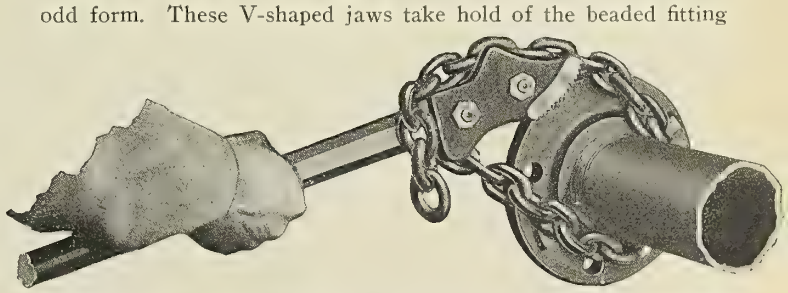
A good point about the hammers placed on the market by the Helwig Manufacturing Company at St. Paul, Minn., is that they are cushioned in the handle, thus conducing to ease of operation with absence of jar. They are very powerful for their



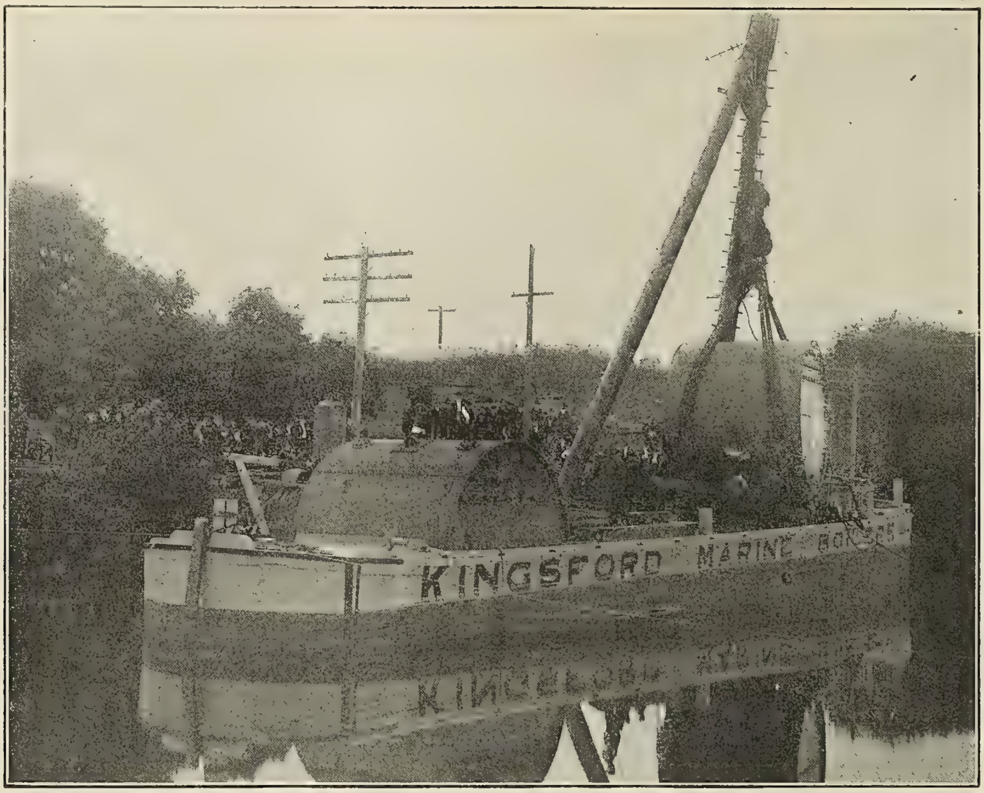
weight, as the 9-inch stroke hammer weighs only 14 pounds and handles rivets up to 1¼ inches. The chipping hammers may be used within three-fourths of an inch of the corner of a wall. The valve is made of solid steel, working in a phosphor bronze cushion, which is replaceable. The throttle valve, barrel and piston are also of steel. The throttle is very sensitive and easy of operation.

The Ideal Chain Wrench.

The Ideal wrench, placed upon the market by Kroeschell Bros. Co., Chicago, presents a radical departure from all the existing types. It has a double biting surface in either of its jaws: the outer one has flat serrated edges, which will grip the pipe securely, the same as ordinary chain wrenches, and which are so arranged that the gripped article cannot be crushed; the inner biting surface has jaws of the shape of a wide V, which are especially designed to grip beaded fittings or valves, flanges and castings of odd form. These V-shaped jaws take hold of the beaded fitting



or irregular shaped article at two points, one jaw on each side, and this assures an absolutely firm grip, just the same as the grip on pipe or on a flat surface. The automatic chain lock consists of an incline or slide toward the lock. The operator, by simply pulling the chain, causes it to drop into the lock, with all slack taken up. The chain, while locked, is held with absolute security, even if used in an inverted position. Another advantage is the ease with which a break in the chain is remedied. Such breaks arise generally from the chain wearing on the pipe, hence occur at a short distance from the jaws.

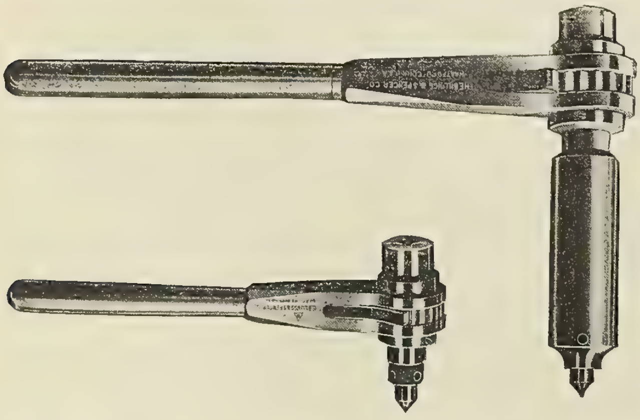


Marine Boilers Shipped by Canal Boat.

The illustration shows two large marine boilers, built by the Kingsford Foundry and Machine Company, of Oswego, N. Y., and shipped to New York for use in a sea-going vessel by means of the Oswego and Erie canals. The boilers are of the regular Scotch cylindrical return tubular type, being single-ended and fitted each with four furnaces. The mean diameter is 14 feet 6 inches and the length, which is 12 feet 6 inches, is in one piece, making the courses of the boiler each 12 feet 6 inches long. The furnaces are of a standard corrugated type, 38 inches in mean diameter. There are three hundred and eighteen tubes 3 inches in diameter and 8 feet 10 inches long. Each boiler weighs 55 tons.

New Ratchet Drill.

The device which we illustrate is being manufactured by the Billings & Spencer Company, of Hartford, Conn., in four styles, known respectively as the genuine packer, the boiler, the railroad, and the Billings double-acting ratchet. The latter can be changed



from a right-hand to a left-hand ratchet by moving a pawl. The boiler ratchet has been especially designed for use in awkward corners of boilers. All these ratchets are drop forged of steel, and all working parts are hardened and polished. They can be furnished in several sizes.

Bilge Siphon Shoes for High-Speed Vessels.

Editor MARINE ENGINEERING:

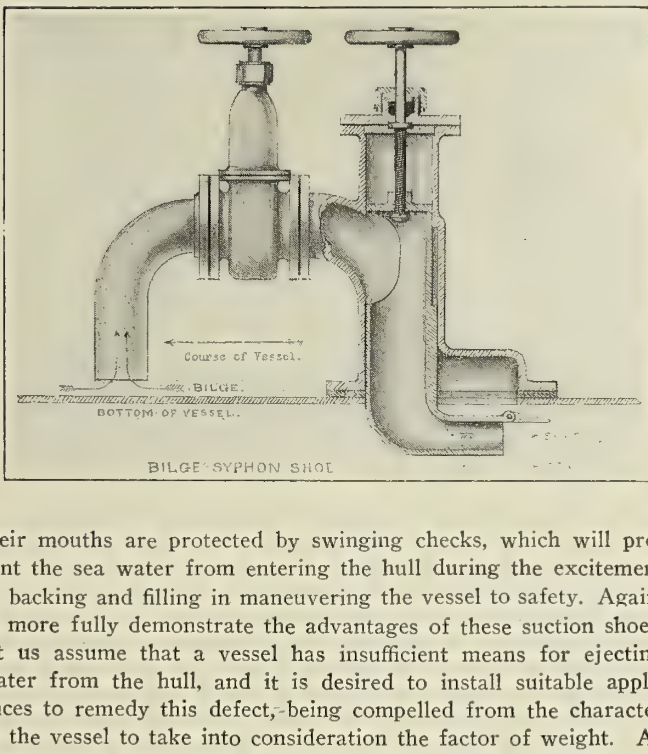
From the frail structure and economic equipment of light-draft, high-speed steam vessels, such as are employed in this and foreign countries for scouts, destroyers, and torpedo boats, the writer is of the opinion that these frail craft in the presence of an enemy can soon be put *hors de combat* by a few well-directed shots from rapid-fire guns. As weight is quite a factor in their construction and equipment, considerable sacrifices are made for speed, and their complement of auxiliaries is reduced to the minimum, with manifold duties to perform. The appliances for ejecting water from their bilges are limited to one or two light service steam pumps of small capacity, several steam siphons, and occasionally a bilge injection, which are sufficient for ordinary cruising purposes, barring accidents. In the time of great need, however, as in the presence of an opposing fleet, should their hull receive punctures from projectiles, at or below their water-line, they will soon fill and turn turtle, and a pawn in the game of war is lost at a critical moment.

To increase the efficiency of this arm, so that it may be possible for them to reach their goal and create confusion to the enemy, the writer suggests the equipment of these vessels with a series of siphon shoes, of the description presented in the accompanying sketch. By the installation of this device in the several amidship compartments, these vessels will be more able to approach an enemy and inflict fatal injuries to hulls, and should they receive in return what was previously termed serious punctures, they can speed away to a harbor of safety, or make temporary repairs in transit, and again become a factor.

This bilge siphon consists of a cylindrical composition case expanded at the lower end to form a housing for the shoe. Its side is pierced with a curved nozzle having a flange for the reception of a gate valve. This gate valve has a copper bilge connection with easy radii, and is tinned inside and out to prevent galvanic action. The ends of the case are flanged to receive a bonnet and for securing to a reinforce plate attached to hull. Enclosed in this case is another cylinder having its lower end bent at an angle of 90 degrees, or parallel to the water-line of vessel, which forms the suction shoe in this device. The bottom of this shoe is flattened to conform to the shape of hull, so that when housed within the case there is no obstruction to catch seaweed or floating *débris*, or to retard the progress of the vessel.

To illustrate the advantages of this device to vessels of the character under consideration, let us assume that they are equipped with it, and that they have received, in an attack, serious injury from projectiles piercing the hull below water-line, and that more water is entering these fractures than the steam appliances can eject. By speeding away from the zone of fire and projecting the suction shoe into the sea, and opening the gate valve on bilge connection, the bilge water will be drawn into the sea in such quantities as the area of shoe will permit. The sea in rushing past the mouth of these shoes creates a partial vacuum, sufficient to overcome the pressure of shallow depths, and with the assistance of the atmospheric pressure upon the bilge water it will be forced over the loop into this void, and when the circuit is established the water will continue to flow through these shoes into the sea as long as there is water in the compartment, and the vessel is moving swiftly through the sea.

For precautionary measures, these shoes can be projected into the sea as soon as the vessel arrives within the range of fire, as



BILGE SYPHON SHOE

their mouths are protected by swinging checks, which will prevent the sea water from entering the hull during the excitement of backing and filling in maneuvering the vessel to safety. Again, to more fully demonstrate the advantages of these suction shoes, let us assume that a vessel has insufficient means for ejecting water from the hull, and it is desired to install suitable appliances to remedy this defect,-being compelled from the character of the vessel to take into consideration the factor of weight. As light service steam pumps are generally employed for this purpose, we will compare their weight and efficiency to that of a bilge siphon shoe. A steam pump capable of ejecting a 4-inch stream of water from the bilge of a vessel, will weigh approximately, with its manifold connections, 1,800 pounds. A bilge siphon shoe and its connections, capable of performing the same amount of work, will weigh about 300 pounds, which gives a difference of 1,500 pounds between the two methods for removing the same amount of bilge water, without using steam from the generators, which can be advantageously employed at these critical periods in driving the main engines.

From the above deductions, one steam pump will weigh six times as much as one bilge siphon, or, the pump will weigh as much as six siphons, which are capable of removing from the hull six times as much water as one pump, when the vessel is moving rapidly through the sea. The writer does not wish it to be understood from the above remarks that he advocates the removal or entirely doing away with steam pumps for removal of bilge water; he merely wishes to demonstrate that these bilge siphons are an economic equipment for light-draft, high-speed vessels for the removal of water from hull in an emergency, in comparison to the weight and efficiency of a series of steam pumps to perform the same service under like conditions.

As economy of space in vessels of this type requires the installation of their auxiliaries in congested places, these siphons can be fitted to skin of vessel under the floor plates, with the wheels for operating the shoe and valve protruding. By having non-rising stems to valve and shoe, it is possible to operate these siphons from the deck by gearing the wheels and extending a stem up through a deck plate. George C. Stanley.

TECHNICAL PUBLICATIONS.

Transactions of the Institution of Naval Architects. Volume XLVII., 1905. Published in two parts in separate volumes. Size, 8½ by 11 inches. Pages, 433. Plates, 88.

The scope of this work can be best indicated by listing the papers included in the text. It will be noted that in each case the papers were followed by discussions by competent naval architects, and that in many cases the discussions, in the variety of information brought out, are of even more value than the papers. The list is as follows:

PART I.

Design of the Antarctic Exploration Vessel *Discovery*.

Armored Cruisers *Kasuga* and *Nisshin* of the Imperial Japanese Navy.

The Russian Volunteer Fleet.

The Strength of Ships, with Special Reference to Experiments and Calculations Made Upon H.M.S. *Wolf*.

The Influence of the Proportions and Form of Ships upon their Longitudinal Bending Moments Among Waves.

Some Experiments on Structural Arrangements in Ships.

Model Experiments on Hollow *versus* Straight Lines in Still Water and Among Artificial Waves.

The Effect of Acceleration on Ship Resistance.

The Effect of Motion Ahead on the Rolling of Ships.

Some Results of Model Experiments in Deep and in Shallow Water.

PART II.

Margins and Factors of Safety, and their Influence on Marine Designs.

Notes on the Variation of Angular Velocity in the Shafting of Marine Engines.

A Method of Preventing Vibration in Certain Classes of Steamships.

The Admiralty Course of Study for the Training of Naval Architects.

Submarine Signalling by Means of Sound.

Naval Strategy and Tactics at the Time of Trafalgar.

The Ships of the Royal Navy as they Existed at the Time of Trafalgar.

Classification of Merchant Shipping (Illustrated by a Short History of Lloyd's Register).

Experiments with Models of Constant Length and Form of Cross Sections, but with Varying Breadths and Drafts.

Experiments on the Effect of Depth of Water on Speed, Having Special Reference to Destroyers Recently Built.

Deductions from Recent and Former Experiments on the Influence of the Depth of Water on Speed.

Fractures in Large Steel Boiler Plates.

A Comparison of the Performances of Turbines and Reciprocating Engines in the Midland Railway Company's Steamers.

Notes on the Causes of Accidents to Submarine Boats and their Salvage.

Faulty Diction; or Errors in the Use of the English Language and How to Correct Them. By Thomas H. Russell. Pages, 149. Size, 2½ by 5½ inches. George W. Ogilvie & Company, Chicago. Price, cloth, 25 cents; flexible leather, 50 cents.

This little pocketbook gives a considerable amount of information regarding the pronounciation and proper use of words which are continually mispronounced or misused in ordinary speaking and writing, and would be of great value to anyone whose work requires very much of either.

The Mechanical World Pocket Diary and Year Book for 1906. Nineteenth annual issue. Size 4 by 6¼ inches. Pages 391; figures 73. Manchester: Emmott & Company, Ltd. Price 6d. net.

Within a small compass, in a book conveniently carried in the pocket, have been collected a large number of tables of engineering data of all descriptions, from the usual mathematical and trigonometrical tables to horsepower, steam, and vacuum tables, tables of the properties of I- and Z-bars, shafting and the strength of materials, electrical constants and wiring tables, hydraulic data, tables of bolts, nuts, and threads, conversion tables between metric measures and the corresponding British units—in short, all of the usual data and tables to be found in the general engineering reference books. In addition to this are to be found many "chapters" or notes on various subjects of an engineering character, such as engines, boilers, valve setting, pumps, oil and gas engines, belt and rope driving, electric machinery, power transmission and devices, and a multitude of other items of interest to the engineer.

In the rear of the book are a diary and blank pages for memoranda. A splendid and very complete index renders the book exceedingly easy of access, and adds enormously to its value as a work of ready reference.

Steam Power Plant Data Book. By Charles E. Lucke, Ph.D. Size 8 by 13 inches. 75 double pages. New York: D. Van Nostrand Company, 1905. Price $1.50.

This book is intended for use in connection with a very complete test of a steam-power plant or for recording results of a professional inspection of such a plant. It takes up in great detail the matter of the various items entering into a plant, with spaces on the left-hand pages for sketches and on the right-hand pages of corresponding number for compilation of the data involved in the test or acquired at the inspection. Something of the completeness of the work may be evidenced by noting the fact that it goes into such subjects as ash handling, coal handling, flues, chimneys, fan blowers, boiler feed, piping, feed-water heating and economizers, condenser systems, water purification, lubricators, heating, ventilating, and elevator systems of buildings, etc. For the purpose for which it was designed it appears to be exceptionally complete.

The Story of Noah's Ark. By E. Boyd Smith. Size 8½ by 11 inches. Pages 56. Boston: Houghton, Mifflin & Company, 1905. Price $2.00 net.

This is a Christmas book containing twenty-six full-page illustrations in colors with pictorial title page and cover. It depicts the story of Noah and the ark from the time when the first warning was sounded until the ark had come to land, and its crew and passengers had again found footing on the earth. The illustrations, showing a great variety of animals pair by pair, are splendidly drawn and gorgeously colored, and many amusing situations are described and illustrated. The text accompanying the illustrations is very brief and has a dry and solemn tone well in keeping with the gravity of the subject, but is written in such a manner as to increase the humor of the entire production. The book is bound to be popular with all who see it.

Practical Planer Kinks for Planer Hands. By Carroll Ashley. Size 4¾ by 7½. Pages 80; figures 32. New York: Hill Publishing Company, 1905. Price $1.00.

This little book is stated in the preface to have been written for the planer hand by a planer hand, and covers a large scope of practical subjects connected with the use of the planer, and the various attachments which go with it. The writer brings to his task the value of the experience obtained during a seven years' apprenticeship on the planer, and gives a great many pointers which ought to be of much value to those interested. Most of the illustrations have already appeared in *American Machinist,* and are well adapted to bring out the points made by the author.

The Panama Canal: System and Projects of Lindon W. Bates. Size, 8½ by 11 inches. Pages, 180; plates, 15. Published by the author, New York, 1905.

The projects, briefly described in Marine Engineering for June, 1905, are here given a very comprehensive description, and a large amount of data and information referring to the geologic and climatic conditions on the Isthmus of Panama is collected into the volume, which is thoroughly illustrated with half tones and diagrams in addition to the plates above mentioned. The entire proposition is carefully covered as a result of personal inspection of conditions on the Isthmus, and the two projects which Mr. Bates has placed before the Commission, together with a third or supplementary project, are given full description. The arguments presented seem to show that they cover the ground much more thoroughly and satisfactorily than any other scheme presented up to date. It might be mentioned that one of the strong points brought out is concerned with the sanitary proposition, which other projects have very largely ignored. The scheme of terminal lakes advocated by Mr. Bates not only conduces to ease and cheapness of construction, but obliterates entirely the swamps now existing at the two ends, and well known to be beautiful breeding grounds for the fever-bearing mosquito. The fifteen plates mentioned cover relief maps of both of Mr. Bates' projects, plans of dams, dykes and locks of various projects, harbor plans, comparative excavation profiles and diagrams dealing with not only the engineering but the financial end of the proposition.

Bureau Veritas: General List of Merchant Shipping of All Nations. Size 7 by 10 inches. Two volumes, price £3 3s. Volume I, Steamers, pages 1,563; price £1 15s. Volume II, Sailing Vessels, pages 1,230; price £1 10s. Bureau Veritas, 8 Place de la Bourse, Paris; 155 Fenchurch street, London, E. C.; 17 State street, New York. 1905.

These books give lists of all the steamers and sailing vessels in the world, with information covering such items as tonnage, date of construction, material of construction, draft of water, etc., for sailing vessels, and the same for steamers with additional figures covering machinery, etc. There are also tables acting as a sort of cross index, giving the various companies and other owners operating these ships, so that any ship may be located from either the point of view of its name or that of owner.

QUERIES AND ANSWERS.

All reasonable questions concerning marine engineering received from and signed by subscribers will be answered by the Editor in this column. All communications must bear the name and address of the writer.

Q. 307.—Please answer the following in your next issue:

(*a*) What formula will give weight of flywheel rim suitable for gasoline marine engines of following types?

1 single-cylinder, two-cycle.
2 " " " "
3 " " four-cycle.

(*b*) On page 173 of your April issue for 1905, giving an account of the auto-boat *Hilda,* appears the following formula:

$$M = \sqrt[3]{\frac{B^2V^3}{F}} = \sqrt[3]{\frac{0.27 \times (17.11)^3}{45}} = 3.11.$$

What do M and B represent, and how is the formula applied?

The Admiralty constant for the *Hilda* $= \dfrac{D^{\frac{2}{3}} \times V^3}{I.H.P.} = 150.2$, a fine performance for her size.

(*c*) What weight, at a radius of 12 inches, will twist off a Tobin bronze shaft 1 inch in diameter and 12 inches length, subjected to torsion?

(*d*) Have any experiments been made to determine the tow-rope resistance of launches of 40-foot length and under, similar to those made by Froude on the *Greyhound?* Or the actual thrust as described in your issue of August, 1903, page 414, in the case of the tug *Vlaardingen?*

E. F. K.

A.—(*a*) For the weight of a fly-wheel rim the formula used is $W = \dfrac{\Delta E g}{V^2 K}$, where W is weight in pounds, ΔE is the difference between the average crank effort of the engine and the maximum crank effort (or minimum, whichever may give the greater difference), g is the acceleration due to gravity (= 32.2 feet per square second), V is the mean velocity of the rim in feet per second, and K is the maximum change of velocity in the rim during one revolution, divided by the mean velocity. This formula, which is a perfectly rational one, is derived from the consideration of the effect which the inertia of the rim will have in steadying the rate of revolution, and is applicable to the case of any engine which may be under consideration, provided we have data sufficient to enable us to determine the amount of energy produced by the explosions of the gasoline and the expansion during the different operations of the stroke.

(*b*) The formula given on page 173 of our issue for April, $M = \sqrt[3]{\frac{B^2 V^3}{F}}$, is one relating a propulsive coefficient of the vessel to its block coefficient. It is in all respects similar to the Admiralty coefficient quoted by our correspondent, and serves simply as a means of comparison between performances of different vessels. The M is the coefficient in question, B is the block coefficient, which in this case was 0.51, V is the speed in knots, and F is the horsepower.

(*c*) The formula for relating the resilience of a shaft to the effort to disrupt it by torsion is $Pa = \frac{\pi \theta G d^4}{32 l}$ where P is the force operating at a distance a from the axis of the shaft, $\pi \frac{d^4}{32}$ is the polar moment of inertia of the section of the shaft, G is the modulus of elasticity of the material, l is the distance between the point of application of the twisting force and the point of support of the shaft, and θ is the angle through which the outer end of the shaft turns during the process. Without special knowledge on the properties of Tobin bronze, it would be impossible to give a quantitative answer to the question asked, but the general method of analysis is that shown by the formula.

(*d*) Experiments were conducted in England last spring on full-sized models of gasoline launches from 25 to 40 feet in length, by towing them from a spar rigged out from the deck of a torpedo-boat destroyer, and very valuable results obtained. Particulars of these tests, with numerous photographs, were published by *Engineering*, of London, soon after the tests were made.

Q. 308.—Kindly answer the following relative to the screw propeller:
(*a*) What is the difference between real or positive and apparent slip?
(*b*) What is the difference between the developed and the projected surface of a propeller?
(*c*) What is the disk area?
(*d*) What is the surface ratio?
G. J. L.

A.—(*a*) A propeller acting to drive a moving ship is operating in water disturbed by the passage of the ship through it. That is, water follows to a certain extent the motion of the ship, and this extent is greater the nearer the particle of water is to the side of the ship. It results that the propeller is acting in water moving in the direction of the motion of the ship. If, therefore, we calculate the slip of the propeller as based upon the water in which it is actually moving, the resultant figure will be greater than if we calculate the slip basing it upon a stationary point or upon the water at some distance from the ship. In other words, the apparent slip, which is calculated from still-water conditions, is the difference between the pitch of the propeller multiplied by the number of revolutions, and the amount of advance of the propeller and ship during the period of time for which the revolutions are counted. On the other hand, the true slip is the difference between the product of the pitch of the propeller and the number of revolutions in a given time, and the motion of the propeller and ship with relation to the moving water in which the propeller acts.

(*b*) The developed area of a propeller blade is the actual total area of the blade; while the projected area is that portion of the area which would be seen by an observer stationed somewhere in the line of the propeller shaft but at a considerable distance from the propeller. The projected area is less than the developed because from the position at which the area is seen by the observer the actual or developed area of the propeller is viewed at an angle, and its dimensions proportionately foreshortened.

(*c*) The disk area is the area of the circle swept by the tips of the blades; in other words, it is the area of a circle whose diameter is equal to the diameter of the propeller.

(*d*) The surface ratio is the ratio between the developed area of the propeller and the disk area.

Q. 309.—Kindly give in the column of Queries and Answers some formula for figuring the size of expansion bends in steam pipes necessary for a given length of pipe and a given change in temperature. If any treatise on this subject is in print you would oblige by mentioning same.
A. G. C.

A.—We know of no formula for figuring the radius of expansion bends in steam pipes except in the one case where the bend is a complete loop, in which case Bauer & Robertson give a formula $A = 2\sqrt{D \times L}$, where A is the vertical height of the coil, D is the external diameter of the pipe, and L is the distance between the two closed ends of the coil, all measured in inches.

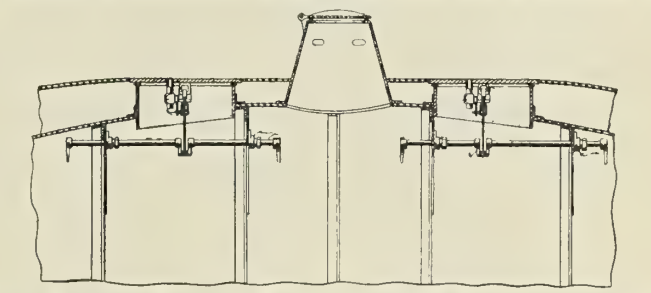
Civil service examinations for mechanical draftsmen for work on the Panama Canal will be held December 6 at the usual places throughout the United States, and applicants should apply to the United States Civil Service Commission for form 1312. The subjects of examination include mathematics and practical calculations, drawing, materials of construction, and a statement of training and experience. The salaries range from $1,200 to $1,800.

Examination is announced for December 6 and 7 to fill two vacancies for fourth assistant examiner in the patent office at $1,200 per annum, the subjects covering physics, chemistry, mathematics, technics, mechanical drawing and French or German. Applicants should apply for form No. 1312.

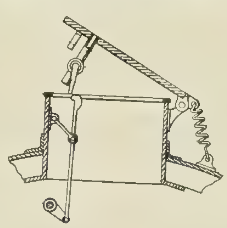
SELECTED MARINE PATENTS.

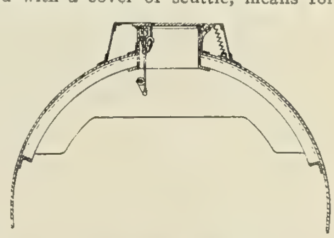
799,714. MEANS OF ESCAPE FROM SUNKEN SUBMARINE AND SIMILAR BOATS. F. T. CABLE, NEW SUFFOLK, AND L. Y. SPEAR, GREENPORT, N. Y., ASSIGNORS TO ELECTRIC BOAT COMPANY, NEW YORK.

Claim.—2. A boat or vessel of the character described, having a plurality of air locks or compartments formed in the upper part of its interior by



means of transverse watertight bulkheads which extend only part way down through the depth of the boat, hatches in the hull opening one into each of said compartments and provided with a cover or scuttle, means for

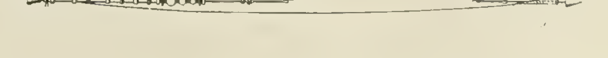


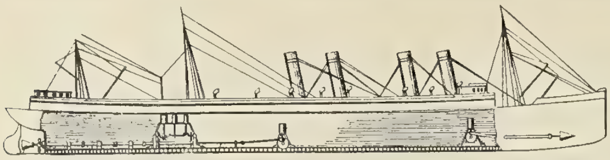


securing said covers and for releasing them independently from one of the adjacent air locks, and means also for controlling the escape of air from such air locks and operatable from adjacent air locks. Five claims.

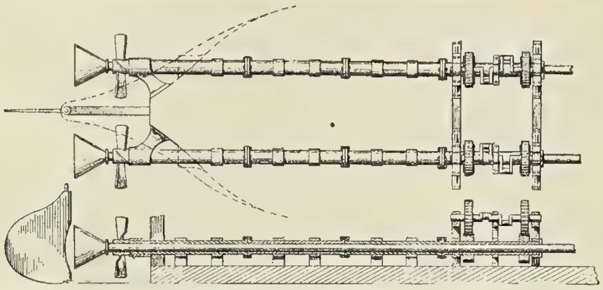
800,481. BOAT PROPELLER. MIGUEL PEREZ, ST. LOUIS.

Claim.—1. In vessel-propelling devices, a pair of tubes arranged one on each side of the bow of the vessel and extending through the hull in a line





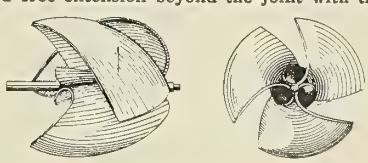
parallel with the longitudinal plane of the keel, a second pair of tubes arranged at the stern of the vessel and projecting through the hull, also on lines parallel with the plane of the keel, rods extending through the tubes, conical propellers at the outer ends of the rods, and independent driving means for the pairs of rods at the bow and stern, said propelling means being arranged to move the forward propellers in one direction, while the aft propellers are simultaneously moved in the opposite direction.



2. In vessel-propelling devices, a screw propeller, a tubular shaft carrying the same, means for revolving the shaft, a reciprocatory rod extending through the shaft, and a conical propeller secured to the rod to the rear of the screw propeller. Three claims.

799,800. SCREW PROPELLER. FRANK A. NEWELL, FALLAN, MONT.

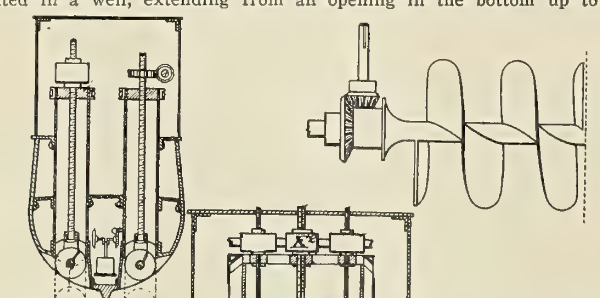
Claim.—1. In screw propellers, two or more spiral blades joined together with a rotary shaft, each blade being scoop-shaped and provided with a hook-shaped free extension beyond the joint with the shaft.



2. In screw propellers, two or more spiral blades joined together on a rotary axis and each blade provided with a hook-shaped free extension beyond the axis. Two claims.

800,184. PROPELLING VESSELS. ROCCO STOLA, NEW YORK.

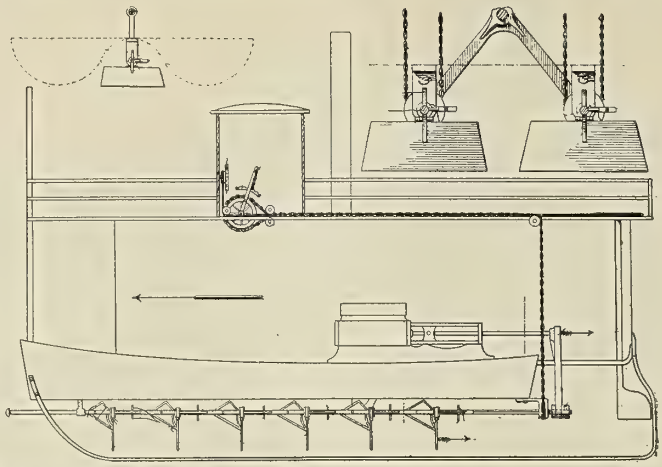
Abstract.—Two screw propellers are provided at or near the mid-length of the vessel, with means for thrusting each downward into a position where it can act efficiently on the water when it is to be used. Each propeller is mounted in a well, extending from an opening in the bottom up to any



height desired. It may be quite out through the upper deck. The lower end of each well is flared at the front and rear, so that the water finds ready access at the front and also ready discharge at the rear even when the propeller is drawn up so as to be entirely protected within the general lines of the bottom. Six claims.

801,560. BOAT-PROPELLING MECHANISM. HOWARD Y. THOMAS, CHARLEROI, PA.

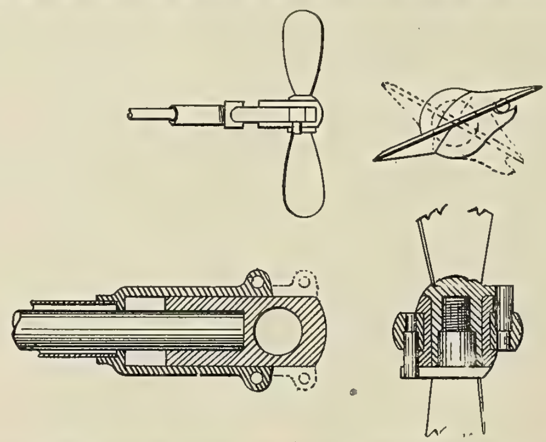
Claim.—9. A propeller-shaft mounted for reciprocation and oscillation, paddle-carrying members mounted for rotation upon said shaft, paddles hingedly connected with said members, paddle-engaging lugs radiating from



the shaft, disposed respectively in front and in rear of the paddles at approximately right angles to one another and having paddle-engaging faces at approximately right angles to the axis of the shaft, auxiliary paddle-engaging lugs disposed in front of the paddles diametrically opposite to the above-mentioned lugs in front of the paddles, and having obliquely-disposed paddle-engaging faces, and means for rotating the shaft in its bearings and securing it at various adjustments. Fourteen claims.

801,684. PROPELLER-WHEEL. H. J. PERKINS, GRAND RAPIDS, MICH., ASSIGNOR OF ONE-THIRD TO F. L. PERKINS AND ONE-THIRD TO C. E. PERKINS, GRAND RAPIDS, MICH.

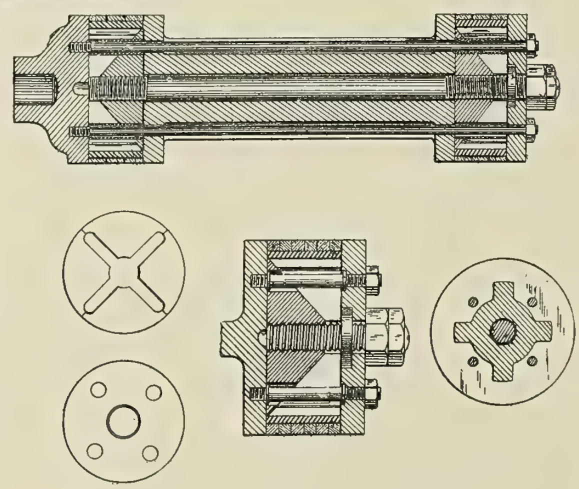
Claim.—2. The combination with a propeller-shaft, a hub rigidly secured thereto, blades provided with shanks at their inner terminals, one of said shanks having a receptive construction and passing entirely through the hub, the shank of the other blade being centrally journaled in the shank of the first-named blade and extending into the latter a depth equal to the diameter of the hub, and having a bearing solely within the shank of the



first-named blade, each blade also having a shoulder which fits closely against the hub, a yoke slidably mounted on the hub and shank, oppositely-extending pins rigidly secured in the yoke and arranged to engage portions of the propeller-blades, the latter having recessed flanges to receive pins, and means connected to the yoke for imparting longitudinal movement to the latter with respect to the hub to simultaneously change the angle of the blades. Two claims.

801,985. PACKING-EXPANDING DEVICE. EADS JOHNSON, BAYONNE, N. J., AND WILLIAM McDERMOTT, PORT RICHMOND, N. Y.

Claim.—1. In combination, a piston-follower; a piston end piece; a threaded member passing through said follower and rotatably mounted in said end piece; a spreader which is mounted free to travel along said threaded member when the latter is rotated; expandible devices actuated by the movement of said spreader; and means for securing said follower and end piece together.



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" 103, A. E. Pittman, Box 378, New Bern, N. C.

TRADE PUBLICATIONS.

"Bright tin plates" is the subject of a pamphlet issued by Merchant & Company, Inc., Philadelphia, Pa., telling of this company's extensive tin plate works and its method of manufacture. A free copy of this pamphlet will be forwarded upon application.

Nautical instruments are described in a 30-page illustrated catalogue issued by the Keuffel & Esser Company, 127 Fulton street, New York city. Sextants of many patterns, binnacles of half a dozen kinds, peloruses, liquid compasses, dry compasses, aneroid barometers, marine glasses, and, in fact, every instrument that a navigator uses will be found listed in this catalogue, which also illustrates and describes drafting-room tapes and instruments of all sorts.

Clocks—marine, pendulum, ships' bell, time lock, etc.—are described and illustrated in Catalogue A, issued by The Chelsea Clock Company, 16 State street, Boston, Mass. These clocks are all made in several styles, and are finished in yellow brass, nickel, black oxide, copper bronze, green bronze, copper plate, polished or satin silver, polished or satin gold. No yachtsman or ship owner should fail to send for a copy of this catalogue, in which he will be pretty sure to find a description of the kind of clock he is looking for.

"Mound" packing tools and cold chisels are described and illustrated in a folder issued by the Mound Tool and Scraper Company, 712 Howard street, St. Louis, Mo. The folder states "there are six scrapers in each set. They vary in size from 8 to 14 inches. The scrapers are made of the best tool steel, carefully forged, tempered, and polished, so that they are true in shape and possess the proper temper for effective work. In oak case, conveniently made, so that they can always be found together in the tool room."

Indicators, valves, and gauges are profusely illustrated and concisely described in Catalogues 8B, 9B, and 10B, issued by the American Steam Gauge and Valve Manufacturing Company, 208 Camden street, Boston, Mass. This company manufactures the American-Thompson Improved Indicator, and in the catalogue devoted to this subject—8B—illustrates and describes the evolution of the indicator from the earliest period of its use to the present day. The company has in its possession some of the oldest types of indicators, such as were used in 1830. A great many different kinds of indicators are described in this catalogue, and any one interested in the subject should send for a copy.

Pneumatic appliances for marine work are the subject of an illustrated catalogue issued by the Philadelphia Pneumatic Tool Company, Philadelphia, Pa. Among the tools illustrated and described are portable side-light cutters; portable backing counterbores for armor bolt holes; channel plate reaming attachment for pneumatic drills; portable pneumatic drilling, reaming, and countersinking machines; pneumatic deck calking machines; riveter frames and yokes; riveting hammers; rotary drills; reversible wood boring machines, and portable pneumatic grinders. The company manufactures a complete line of pneumatic tools and appliances for every service.

Mechanical oil pumps for steam engines, pumps, etc., are described and illustrated in a pamphlet issued by the Lunkenheimer Company, Cincinnati, Ohio. Regarding its double-feed, mechanical oil pump, the company says that it is adapted for large tandem or cross-compound engines, where a reliable pump is required for two independent feeds; as, for example, to tap the steam chest over the steam valves of a Corliss engine, and in this way get the oil at once where it is most needed. The action of this pump is positive, and with every stroke of the plungers the oil is forced directly into the steam chests or cylinders. The pamphlet contains a number of letters from users of the Lunkenheimer oil pumps, expressing great satisfaction with their action.

The "Long Arm" system of power doors and hatch gears, for the preservation of life and property at sea, is the subject of illustrated Bulletin No. 5, issued by The "Long Arm" System Company, Cleveland, Ohio. The bulletin states that the manufacture and installation of several hundred "Long Arm" power doors is now going on, or accomplished, in the United States navy and in the merchant marine The most important and effective life-saving device on ships, so this company states, in case of collision or other skin puncture from shell, torpedo, derelict, iceberg, or rock, is one rendering the hull itself unsinkable. The "Long Arm" system is said to secure efficient bulkhead insurance at a cost of less than 1 per cent. of the cost of the ship. A complete description of this company's equipment follows and should be of great interest to ship builders and naval architects.

The Dean Steam Pump Company, Holyoke, Mass., is distributing Catalogue No. D-23, reviewing the principles and advantages of the several types of condensers as applied to steam engines.

"Self-Instructing Practical Books" is the title of a 20-page catalogue issued by the Norman W. Henley Publishing Company, 132 Nassau street, New York city.

"A Short Story of Henry Maudsley," and "The Value of Heat Treatment" as applied to steel forgings, are the subjects of a pamphlet issued by Wyman & Gordon, Worcester, Mass.

"The A. B. C. Horizontal Engine" is the title of an illustrated catalogue issued by the American Blower Company, Detroit, Mich. This engine is designed for blower work, and is made extra heavy throughout, to enable it to endure the severest strain. The Rites-Carpenter automatic fly-wheel governor is furnished with the engine.

Ice boats for immediate delivery are advertised by Merriman Brothers, 162 Commercial street, Boston, Mass. These boats are designed by H. P. Ashley, and are so constructed that they may be readily shipped by freight or express. They weigh about 450 pounds. To assemble them, so the advertising folder states, "requires two hands, two hours, and a monkey wrench."

The protection of steel is the title of a folder issued by the Joseph Dixon Crucible Company, Jersey City, N. J. The folder states that "the presence of sulphurous gases, cinders, and steam, combined with exposure to the elements, provide conditions most favorable to the rapid corrosion of steel work. Time tests the efficiency of a paint. Dixon's silica graphite paint has been on the market forty years."

"Safety at Sea" is the title of a pamphlet issued by the Submarine Signal Company, 247 Atlantic avenue, Boston, Mass. This company has developed and controls a system of signalling by sound under water, which is protected by patents. The purpose of the system is to enable seamen to locate the position of their ships, and of shoals, lighthouses, etc., in foggy weather.

Steam turbines for auxiliary purposes.—The De Laval Steam Turbine Company, 74 Cortlandt street, New York city, is distributing Bulletin No. 3, illustrating and describing De Laval steam turbine alternators. This bulletin states: "The problem of successful operation in parallel of alternating current generators when driven by reciprocating engines has always been a difficult one, and the requirements as to the variation in angular velocity and regulation are seldom fulfilled in machines of small size. In this case of work the De Laval turbine has been particularly successful. The regulation of the turbine is as good as that of the highest-class reciprocating engine of equal size, and the entire absence of vibration in angular velocity permits the most successful operation in parallel or turbine-driven alternating current generators. The De Laval alternating current units are made in sizes of 75, 100, 150, and 200 Kw., 60-cycle, single, two or three-phase, and with voltages varying from 220 to as high as may be required on machines of these capacities. Machines of 25-cycle can also be furnished, but require different size generators, and are somewhat special in their construction. The generators used in the construction of De Laval alternating units are all standard belt-driven type machines, minus the bearings and bed plates. They are mounted on the turbine bed plate, and are direct-connected by means of flexible couplings. The entire unit is self-contained, and requires little foundation other than that necessary to carry the dead weight of the machine.

Air compressors and vacuum pumps are described in an illustrated pamphlet of 48 pages issued by the Clayton Air Compressor Works, 114 Liberty street, New York city.

Wire rope of every description, for cables and hawsers, elevators, tramways, dredging and derrick rope, ships' rigging, etc., is described in an illustrated folder published by the American Steel and Wire Company, Chicago, Ill.

Turbines and centrifugal pumps are described in illustrated bulletin No. 1, issued by the I. P. Morris Company, Philadelphia, Pa., which is owned and operated by the William Cramp & Sons Ship and Engine Building Company, Philadelphia, Pa.

"Interesting Facts About Hydraulic Pumps" is the title of an illustrated folder issued by M. T. Davidson, 141 Broadway, New York city. Several testimonials appear in the folder from parties who are using this pump to their great satisfaction.

The Edson diaphragm pump is the subject of a mailing card issued by the Edson Manufacturing Company, 255 Atlantic avenue, Boston, Mass. The company is making a guarantee trial offer regarding this pump and solicits correspondence on the subject.

Galvanized bars, angles, nails, spikes, plates, etc.—The United Galvanizing Company, 525 Front street, Philadelphia, Pa., is mailing a folder which says "when the mills hold you up and don't make shipments promptly, we can help you out. The next time you are in a hurry, send your order to us."

Ball transmission gear for motor boats and automobiles is described in a pamphlet issued by the New York Gear Works, 56 Greenpoint avenue, Brooklyn, N. Y. These gears are entirely made of spur gears cut from steel blanks with hardened teeth; they run in oil in a case which is dust proof. The pamphlet also describes the Ball positive circulating pump.

Two-cycle marine gasoline engines are described in a booklet issued by the Maxwell & Fitch Company, Rome, N. Y. These engines are said to be very simple in construction, being without poppet valves, valve rods, springs, cams, or reducing levers. The engines are throttle-controlled and are claimed to run with great steadiness.

Machinists' tools are described in a very complete illustrated catalogue of 156 pages, issued by the Brown & Sharpe Manufacturing Company, Providence, R. I. Rules, squares, micrometer calipers, gauges, accurate test tools, milling machines, grinding machines, gear-cutting machines, screw machines, and cutters are the principal tools manufactured by this company, which will be pleased to forward a free copy of its catalogue upon application.

Those interested in machine tools of any kind should ask to be put on the free mailing list of *The Progress Reporter*, published by the Niles-Bement-Pond Company, 136 Liberty street, New York city. The object of this publication is to keep the employees of the company and the public in general, informed as to the new machines and devices which are constantly being brought out. No. 5 illustrates and describes a lathe with a new change-gear device; a new duplex milling machine for forge work; a new 100-inch quartering machine for driving wheels; a 72-inch planer with side heads having taper attachment; magnetic relief applied to head of 14-foot planer; a four-bladed frame drill; a two-spindle vertical drill; a 10-foot radial drill; turret boring and turning mills; heavy bar shears; straight and taper reamers, etc. This number of *The Progress Reporter* contains a facsimile reproduction of a diploma awarded the Niles-Bement-Pond Company at the Osaka exposition, Osaka, Japan.

Drafting room furniture is described and illustrated in a 32-page catalogue issued by Fritz & Goeldel Manufacturing Company, Grand Rapids, Mich.

Electric hoists for ship yards, machine shops, coal yards, etc., are described and illustrated in Bulletin No. 222, issued by the Sprague Electric Company, 527 West 34th street, New York city.

Saved 13,800 pounds of coal in one day is the title of a folder issued by Warren Webster & Company, manufacturers of the Webster heating system, Camden, N. J.

Sir William Crookes is the subject of the latest brief biography issued by the Bullock Electric Manufacturing Company, Cincinnati, Ohio.

Electric hoists, winches, and capstans, are described in illustrated Catalogue 046, distributed by the C. W. Hunt Company, West New Brighton, Staten Island, N. Y.

Buckeye steam engines are illustrated and described in a 126-page catalogue issued by the Buckeye Engine Company, Salem, Ohio.

Chains, plate and cast washers, and burrs.—The Allegheny Forging Company, Pittsburg, Pa., is distributing folders containing price lists of its various chains, washers, burrs, etc.

Special machinery, for sale by the Garvin Machine Company, Spring and Varick streets, New York city, is described and illustrated in a 32-page catalogue this company is distributing.

"High-Grade Cranks for High-Grade Engines," is the title of a book on forgings for engineers, issued by W. H. Anderson & Sons, manufacturers of tools and forgings, 21 St. Aubin avenue, Detroit, Mich.

"Shutting off the Waste; Some Facts, Figures, and Results of the Economical Operation of Condensing Power Plants," is the title of a pamphlet issued by Warren Webster & Company, Camden, N. J.

A compensating carburetor.—The Maxwell & Fitch Company, makers of gasoline engines, Rome, N. Y., is distributing cards calling attention to its carburetor, which, it states, "gives a perfect mixture for all speeds, without changing the adjustment of the needle valve."

Edson steering gears.—The Edson Manufacturing Company, 255 Atlantic avenue, Boston, Mass., is distributing a mailing card calling attention to its "Meteor" steering gears. The card says "While this gear was first designed for the Emperor William, we make it in less fancy form for fishermen and merchant boats."

"A. B. C." fans and blowers are the subject of an illustrated booklet issued by the American Blower Company, Detroit, Mich., manufacturer of heating, ventilating, drying, and mechanical draft appliances. The company's Type E exhauster possesses novel features which it is claimed do not exist in any other fan. A full description will be sent upon application.

BUSINESS NOTES.

MR. A. N. VAN DEMAN, formerly connected with the Pittsburg White Metal Company, is now general manager of the white metal department of the Atlantic Brass Company, Jersey City, N. J.

CHAINS AND CABLES, FOR ANCHORS, DREDGES, rafts, cranes, etc., are manufactured by the J. B. Carr Company, Troy, N. Y., which has been making chains and cables since 1865.

LAUNCH AND ENGINE AGENCY.—The Lamb Boat and Engine Company, Clinton, Iowa, has arranged for a Chicago agency with H. L. Hoffman, 394 Wabash avenue, who will handle a full line of the boats and engines of the Lamb Company, and who is ready at any time to furnish supplies and anything that launch owners may wish for in connection with their boats.

A LARGE ORDER FOR CHAINS.—Bradlee & Company, Beach street and E. Susquehanna avenue, Philadelphia, Pa., have received an order from the Southern Pacific Company, San Francisco, Cal., for 4,296 feet of marine railway chain. The test of this chain, made under supervision of the H. I. Crandall & Son Company, East Boston, Mass., showed a breaking strain of 462,800 pounds.

A NEAT DESK BLOTTER.—H. B. Underwood & Company, Philadelphia, Pa., manufacturers and designers of portable tools, are distributing blotters for office use; several being fastened together with an ornamental celluloid back, with pictures in several colors representing game cocks fighting, and also showing a picture of the Underwood portable cylinder boring bar.

A PILOT HOUSE STEAM STEERER.—The Dake Engine Company, Grand Haven, Mich., makes a steam steerer which it states is "simple, compact, and durable, and occupies small floor space."

PORTABLE CYLINDER BORING BARS, for boring cylinders and stern-post bearings, are manufactured by the H. B. Underwood Company, makers of portable tools, 1023 Hamilton street, Philadelphia, Pa.

THE NATIONAL ASSOCIATION of Engine and Boat Manufacturers will hold only one exhibition in 1905, and this will be in connection with the Sportsmen's Show in the Madison Square Garden, New York city in February. For this occasion water space has been reserved for the boats.

RAND DRILL FOR GOVERNMENT USE.—The United States government has bought from the Rand Drill Company, 128 Broadway, New York city, twenty-seven "Imperial" pneumatic hammers and drills, for use in connection with the improvements in the harbor of Manila, P. I.

THE STOW FLEXIBLE SHAFT COMPANY, Philadelphia, Pa., reports having received many orders during the past month, among them being a Halsey portable drill for a firm in Vancouver, B. C., an 18-foot flexible shaft, and a large crank pin turning machine for its St. Louis agent, and three electric hammer outfits shipped to Italy for the government navy yards.

FREE SAMPLE OF MAGNETIC PACKING.—That Smooth-On cement rubber packing is magnetic may be proved by any one who will send to the Smooth-On Manufacturing Company, Jersey City, N. J., for a free sample of its cement rubber packing, which will be forwarded in a neat leather case together with a small magnet, to those who mention MARINE ENGINEERING. It will be found that this packing, though as smooth and soft as rubber, contains so much iron that the magnet will hold it suspended in the air.

A KEROSENE HOISTING ENGINE is manufactured by August Mietz, 128 Mott street, New York city, that is stated to be giving perfect satisfaction after eighteen months' trial. The engine is used in hoisting barrels of crude oil and is installed on a barge. Engines of this type, ranging from 2 horse power to 30 horse power, are employed for various purposes, such as driving threshing machines, water and air pumps, etc. They may be adapted to driving portable stone crushers, concrete mixers, and other use where an engine of moderate power is required.

FLAKE GRAPHITE, for the lubrication of air compressors, has been put on the market by the Joseph Dixon Crucible Company, Jersey City, N. J. The company states that certain important conditions are presented in the lubrication of air compressor cylinders which are not encountered in the case of steam cylinders. Dust and grit drawn into the cylinders through the intake frequently cause destructive grinding. The heat is dry and tends to carbonize cylinder oils, especially compound oils, clogging the outlet valves and choking the discharge pipes. If an oil of too low flash point be used, explosive vapors are formed which high frictional heat at some time may accidentally ignite. A number of disastrous explosions of air receivers are said to have been traced to this cause. Dixon's flake graphite, so the company states, forms a perfect lubricant which reduces friction and wholly ends groaning, grinding, and cutting. The company will send free upon application copies of the eighth edition of its pamphlet, "Graphite as a Lubricant," discussing in detail the theory of graphite lubrication and its practical benefits.

WIRE ROPE FOR TOWING HAWSERS.—The Durable Wire Rope Company, 288 Congress street, Boston, Mass., states that its rope is unequalled for ships' rigging, mooring lines, and towing hawsers. The company's cable-laid hawsers are made of four or five durable wire ropes laid around a specially treated Manila center, and are stated to be smaller and more flexible than Manila hawsers of equal strength. Bulletin No. 7 will be forwarded upon application.

"FUEL OIL FURNACES AND EQUIPMENT has been our business for fifteen years," says the Rockwell Engineering Company, 26 Cortlandt street, New York city. Regarding its rivet forge, the company says "control, efficiency, economy, and practical indestructibility are governing qualities of a good heater. . . . This user of air and oil, or kerosene, induces the high, soft heat necessary to a superior forge. Hardening, tempering, and light forging are also feasible."

THREADING AND CUTTING MACHINES, electrically driven, are advertised by D. Saunders' Sons, Yonkers, N. Y. This firm builds an electric motor-driven threading and cutting machine that is claimed to have many advantages over a belt-driven machine. There is nothing to attach or detach; the die head can be pushed to one side and the pipe cut without taking the die head off the machine or pushing the pipe over the chasers and spoiling them. An automatic pump keeps oil constantly on the chasers and cutting-off tool. Catalogue free upon application.

THE CAMDEN ANCHOR-ROCKLAND MACHINE COMPANY, Rockland, Me., reports that in addition to hundreds of tons of anchors which it ships yearly to all parts of the United States and Canada, that within two years it has sold a hundred anchors to the United States navy for use on torpedo boats. In 1901 the Camden Anchor Company, of Camden, Me., was consolidated with the Rockland Machine Company, forming the present company, with headquarters at Rockland. In addition to its anchors, which are made at Camden, the company manufactures the Knox marine gasoline engine at its Rockland plant.

ASBESTOS PACKING FOR SUPERHEATED STEAM.—The H. W. Johns-Manville Company, 100 William street, New York city, states regarding its asbestos "Vulcabeston" packing, that it is furnished in sheet, moulded, and special ring forms for joints; moulded concave and convex rings for movable rods and valve stems; twisted and braided rope form for stop valves; and special extra-graphite forms for work on steam turbines. The company states that "Vulcabeston" is used in nearly every large power plant in the United States where superheated steam has been installed. A pamphlet describing "Vulcabeston" will be sent upon application.

HERTZOG ANTI-FOULING PAINT.—The Hertzog Paint and Varnish Company, 627 Cherry street, Philadelphia, Pa., has received the following letter from Charles E. Small, of the Yacht Masters' and Engineers' Association, foot of 23d street, Brooklyn, N. Y.: "I had the steam yacht *Riviera* painted with your anti-fouling paint August 1, over a brush coat of cement, and it has given satisfaction. I have not had *Riviera* on the dock since, so cannot tell you the condition of the underbody, but along the water line and as far below as I can see it has kept very clean from grass and other sea growth. I am so well satisfied with it I shall use it again next year."

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12 West 31st Street, New York.

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ADDRESSES OF CORRESPONDING SECRETARIES.

No. 1, W. D. Blaicher, 10 Exchange St., Buffalo, N. Y.
" 2, Wm. Kelly, 11 Wall St., Cleveland, O.
" 3, A. L. Jones, 289 Champlain St., Detroit, Mich.
" 4, James A. Macauley, 5802 Indiana Ave., Chicago, Ill.
" 5, Otto Boettger, 1035 E. Hopkins Ave., Baltimore, Md.
" 6, Wm. Arste, 322 Pine St., St. Louis, Mo.
" 7, Wm. T. McElwee, Box 1556, Portland, Me.
" 9, Wm. Bridges, 784 1-2 12th St., Milwaukee, Wis.
" 13, John G. Paulding, 1746 Tulip St., Philadelphia, Pa.
" 14, Joseph F. Dumas, 403 Dauphin St., Mobile, Ala.
" 15, R. L. Skinner, 622 Louisa St., New Orleans, La.
" 17, Jas. D. Robinson, 6th and Columbia Sts., Newport, Ky.
" 18, Wm. Hurst, 715 Walnut St., Cairo, Ill.
" 20, Jos. B. Barry, 206 Keel St., Memphis, Tenn.
" 21, J. H. Foley, 206 N. Mulberry St., Vicksburg, Miss.
" 23, Wm. R. Lewis, 213 E. Front St., Jeffersonville, Ind.
" 24, Hugh L. Edwards, 511 Washington St., Paducah, Ky.
" 26, T. H. Kirkbridge, 228 Bond St., Evansville, Ind.
" 27, L. C. Schwall, 598 S. Madison St., Bay City, Mich.
" 29, James R. Sutherland, Charleston, W. Va.
" 30, E. R. Humphrey, 21 State St., Pittsburg, Pa.
" 33, James J. Waters, 283 Hudson St., New York, N. Y.
" 35, William M. Coombs, 36 East St., San Francisco, Cal.
" 36, Jos. Thomas, 57 Sea St., New Haven, Conn.
" 37, John B. Bender, 1215 Evesham Ave., Toledo, Ohio.
" 38, C. H. Wolford, 73 Starr Boyd Bldg., Seattle, Wash.
" 39, Frank Feeney, 460 E. 12th St., Erie, Pa.
" 40, Chas. Drouet, 1003 Ave. I, Galveston, Tex.
" 41, W. H. Marshall, 343 Holladay St., Portland, Ore.
" 42, Jas. Manning, 802 E. Duval St., Jacksonville, Fla.
" 43, A. J. Wilson, 1327 La Peer Ave., Port Huron, Mich.
" 44, Chas. J. Sullivan, 480 1st St., Manistee, Mich.
" 45, W. L. Salter, care O. S. S. Co., Savannah, Ga.
" 46, D. W. Farrell, Clayton, N. Y.
" 47, J. R. Cook, Sault Ste. Marie, Mich.
" 48, Alfred Hegemer, 140 E. Park St., Sandusky, O.
" 51, H. S. Connell, 12 Ranson St., Muskegon, Mich.
" 53, Harry Stone, Box 445, Marine City, Mich.
" 55, Archie Stalker, Box 883, Cheboygan, Mich.
" 57, E. B. Meeker, 71 Abeel St., Kingston, N. Y.
" 58, E. Capers Haselden, Box 31, Georgetown, S. C.
" 59, George F. Keating, 74 Webster St., E. Boston, Mass.
" 62, N. S. Lawrence, 30 Connecticut Ave., New London, Conn.
" 63, M. J. Burke, 152 Sheridan Ave., Albany, N. Y.
" 65, W. C. Palmer, care Consumers' Coal Co., Charleston, S. C.
" 67, James K. Dole, Saugatuck, Mich.
" 70, Charles T. Smith, 665 Commercial St., Astoria, Ore.
" 72, Wm. T. Findlay, 130 W. Bridge St., Oswego, N. Y.
" 73, E. M. Donahue, 1308 Cherry St., Green Bay, Wis.
" 75, Wm. D. Hemenway, Alexandria Bay, N. Y.
" 76, Orson Vanderhoef, Grand Haven, Mich.
" 77, John P. Hall, 1215 Huron St., Manitowac, Wis.
" 78, J. P. Burg, 2722 Minnesota Ave., Duluth, Minn.
" 80, Edward S. Welch, 338 Hamilton St., Albany, N. Y.
" 81, Jas. L. Sweeney, 206 E. Sarragosa St., Pensacola, Fla.
" 82, Fred H. Gowell, 427 Middle St., Bath, Me.
" 85, John A. Packard, 623 Merchant St., Alpena, Mich.
" 86, Sherman A. Smith, 737 Menekaunee Ave., Marinetta, Wis.
" 87, George B. Milne, 809 Fourth St., Detroit, Mich.
" 88, C. O. Chapman, S. B. Canal, Sturgeon Bay, Wis.
" 89, Geo. E. Willard, 4 Isabella St., Ogdensburg, N. Y.
" 91, A. L. McLaren, 130 W. Walnut St., Ashtabula, O.
" 92, Jos. D. Budd, Box 50, Sta. I, Saginaw, W. S., Mich.
" 93, W. J. Cook, 2220 G. St., N. W., Washington, D. C.
" 94, George R. Jones, Box 222, Washington, N. C.
" 95, P. J. McMahon, Box 199, Key West, Fla.
" 98, C. N. Vosburg, 6323 Patton St., New Orleans, La.
" 100, H. F. Mocine, Honolulu, H. I.
" 101, J. K. Cotton, Box 765, Norfolk, Va.
" 102, Fred. W. Linsemeyer, 210 Clinton St., South Haven, Mich.
" 103, A. E. Pittman, Box 378, New Bern, N. C.

TRADE PUBLICATIONS.

"Imperial Porcelain Lavatories," is the title of a 48-page illustrated catalogue issued by the J. L. Mott Iron Works, 84 Beekman street, New York city.

Those interested in gasoline, electric and steam launches, sail boats, row boats, hunting and fishing boats, canoes, skiffs, etc., should send six cents to the Madison Boat Company, Madison, Wis., for a catalogue now on the press, in which will be listed the company's full line of boats.

"Something New in Air Compression," is the title of a folder issued by the Norwalk Iron Works Company, South Norwalk, Conn. The folder states: "In most establishments using compressed air it is desirable to have two pressures to cover the full range of the requirements. First, there is the demand for 80 to 100 pounds for pneumatic tools, hoists and general power purposes. Second, there is need of air of only 20 to 25 pounds for sand blasting, painting, blowing chips from work, and general uses demanding a low pressure. The usual plan heretofore pursued is to compress all the air to the highest pressure and then by means of a reducing valve, throttle down such amount as is needed by the low pressure system. Such a course is very wasteful, for the power required to raise the pressure from 25 to 100 pounds is entirely lost for so much of the air as is used in the low pressure system. This loss is so great that in most establishments using any considerable amount of air, two entirely separate compressors are employed—one for each system. Such a plan has disadvantages, even apart from the multiplication of machines and consequent expense of installation. The outfit is inelastic in that one compressor cannot be made to help the other. Each machine to secure economy of operation must be designed for the particular pressure intended for it; it furthermore must be made of a size equal to the maximum demands of its own system at any one moment. The greatest demand for low pressure air is not usually at the same time as the greatest demand for high pressure air, and in the same way for other uses, the maximum demands of the two systems generally fall at different times. This leads to the installment of two compressors having a united capacity far in excess of the average demand or even the greatest actual demand on the two at any one moment. Modern compressors for 100 pounds pressure are invariably made on the compound system. The low pressure cylinder furnishes air to the intercooler usually at about 25 pounds pressure, but, for any good reason, this pressure can be changed by proper proportions of the cylinders. Here in one machine we have the two pressures—high and low—and of just the degree needed for the two systems of the factory. But in the ordinary compound compressors the low pressure air in the intercooler is not available for use, for the reason that whenever air is drawn from the intercooler the pressure immediately falls. The low pressure—or first air cylinder—is forcing air into the intercooler, but the high pressure—or second cylinder—is constantly taking it out, and if the pressure is to be kept up when air is drawn out for external use, then the second cylinder must be shut off or cease working to the exact extent that air is removed from the intercooler. It will not answer to shut off the supply to the second cylinder by throttling its intake, for in that case the little air remaining in the inlet ports of this second cylinder falls to a very low pressure and finally approaches vacuum. From this low pressure for a few revolutions the air is compressed to the high pressure of the final discharge. This brings about a very great degree of compression, with corresponding development of great heat. The chances of an explosion are imminent and almost certain in such a mechanical arrangement. The skip valve introduced by the Norwalk Iron Works Company is a most complete and satisfactory solution of the problem. These valves are used as the inlet valves of the second cylinder. The arrangement is such that if the pressure in the intercooler falls below a certain pre-determined point, then these skip valves will remain open and thereby the second cylinder rejects its supply of air, throwing it back into the intercooler. Thus provision is made for the outside draught. The skip valve automatically adjusts the amount, remaining open any number of revolutions or only a part of one revolution, as circumstances may require. In the meantime the speed and pressure governors of the machine will regulate the speed of the machine, making it run to suit the demands of both systems. With these arrangements on the Norwalk compound compressor any quantity of air within the limit of the machine can be drawn off at any time and the speed will be automatically adjusted. The air can be drawn out at two pressures as desired, all at the high pressure, or all at the low pressure, or any proportion at high or at low at the same time. The operation of the compressor is entirely automatic, delivering the air at the pressures desired and in the quantities as used."

"About Oil," is the title of a folder issued by the De La Vergne Refrigeration Company, foot of E. 138th street, New York city. This folder discusses the question of a suitable lubricating oil for refrigerating and ice-making machines.

"File Filosophy," being hints and suggestions as to the proper methods of using files, together with the various applications of the most common files, is the title of a booklet issued by the Nicholson File Company, Providence, R. I. The fourth edition, just issued, consists of forty-six pages, and will be sent free to readers of MARINE ENGINEERING, upon application.

Self-adjusting piston packing, manufactured by the Ambrose Machine Company, Eagle and Provost streets, Brooklyn, N. Y., is described in a booklet issued by that company. The booklet consists in large part of a letter and diagrams from the chief engineer of the Union Railway Company of New York City, showing the beneficial effect of the company's packings. The letter says in part: "Your packing has given great satisfaction, and the cards taken from our engines speak for themselves."

"The Akers auxiliary gear is the outcome of eighteen years' experience with all kinds and classes of steering gears," is stated in a catalogue issued by the Akers Steering Gear Company, 502 Plymouth Building, Chicago, Ill. Among numerous testimonials regarding its gear that the company has received, is the following telegram from Captain Russell of steamer *Pere Marquette No. 17*: "Two hours out of Manitowoc in a heavy sea. Regular steering gear broke down. Used the Akers gear to get in with. Worked fine."

Concerning propellors.—The Norwalk Brass Company, Norwalk, Conn., is distributing a mailing card saying: "Do you realize the importance of the propeller in developing the full power of your engine? To experiment means loss of time and money. Having made a study of propellers under every condition, we are prepared to furnish true wheels of every pitch. Give us the horse power and number of revolutions of your engine and we will save you trouble. We make special speed wheels, weed cutting wheels, and wheels adapted to special hulls."

Marine gasoline engines and launches are described and illustrated in a catalogue issued by the Yacht, Gas Engine and Launch Company, The Bourse, Philadelphia, Pa. The catalogue states that "after several years of rather unsatisfactory experience with so-called 'marine' gasoline engines, due to their many defects of design, material and workmanship, we have decided to build our own, and feel that we have an engine so perfect in all its details as to overcome all the serious faults we have found in most of the engines sold for marine use. The Yacht, Gas Engine and Launch Company was formed by H. E. Danzebecher, a naval architect and marine engineer of several years' experience, who is thoroughly conversant with what is required in the designing of marine engines for yacht purposes, as well as in the design of hulls; and he has incorporated these ideas, gained from practical experience, in the "Crown" yacht engine, which is now brought to the attention of the yachting public. Marine steam engine lines have been followed as far as possible in a gas engine, and the result is a most compact, symmetrical, efficient and handsome engine. We use only the finest grades of steel, bronze and cast iron in all parts of the engine." Regarding the cylinders, water jacket, water circulation, pistons, main bearings, valves, reversing gears, ignition, lubrication, and all essential parts and features of a marine gasoline engine, the catalogue states that the very greatest care has been taken to insure the highest efficiency and strength. A portion of the catalogue is devoted to the hull department, and drawings are given showing the plans of a number of launches and yachts the company has built.

Rocking and shaking grates are described in an illustrated catalogue issued by the Martin Grate Company, Fisher Building, Chicago, Ill.

Reagan's improved chopping grates are described in an illustrated catalogue issued by the Reagan Grate Bar Company, 209 North Front street, Philadelphia, Pa.

An efficient steam flue blower.—The Power Specialty Company, 513 Washington Arcade, Detroit, Mich., issues a folder describing its steam flue blower, which says: "You can't run any kind of a boiler economically unless you keep the flues clean. Soot means loss of efficiency, power, time and money The only thing to do is to clean out the soot and the only practical thing to clean out the soot with, up to the present time, was a small blower attached to a piece of hose with one end connected to the steam pipe. The operator put the little blower in each and every tube in an effort to blow out the soot, and this process was generally repeated several times every day. This must be done from the front of the boiler, against the natural draught. Mr. J. D. Mitchell, chief engineer of the Gilchrist Transportation Co., Cleveland, Ohio, U. S. A., who formerly used the old method says: 'When we used the old-style blower, it necessitated the opening of the britchings and spoiled the draught to the extent that we had to check the engine, to at least half speed for twenty minutes to half an hour for each boiler, where with the Diamond steam flue blower we do a better job and gain steam while blowing, as it operates with the draught and not against it and you do not have to open anything.' Experience has established the fact that keeping the boiler open for a longer period than twenty minutes, causes loss of steam pressure and consequent loss of speed in a vessel or the running of machinery. The cost of additional fuel to regain the lost pressure is probably inestimatable, as it requires the multiplying of waste three times daily for 300 days. If only about twenty minutes is allowed for blowing out the tubes, it means only one-half a minute to each tube, and you can't clean a tube in this time blowing against the natural draught. The front part of the tube may be cleaned as far as you can see, but the back part is bound to be full of soot and it is the rear end of the tubes that is the most dangerous to leave soot in, because it is the most exposed to fire. When some soot is blown out by the old method, it accumulates in the smoke box from which it must again be removed. The Diamond steam flue blower gets rid of all the disadvantages of the old method. It is installed in the rear wall of the boiler and blows the soot, with the natural draught of the boiler, to the front and out through the chimney. The thorough cleaning of all the tubes does not take more than five minutes, because it cleans in each operation a cluster of tubes four feet six inches in diameter. It does away with the most costly loss of steam pressure and is an immense saver in fuel, and consequently there is no loss of speed and no necessity for extra stoking and fuel. It practically does away with the firemen's work which can never be thorough and makes it possible to keep a uniform pressure of steam with perfect ease. Messrs. John H. Boland & Co., 203 Main street, Buffalo, N. Y., users of the Diamond steam flue blower, write as follows: 'Last year we were compelled to carry three firemen, but since putting in the Diamond steam flue blower, we have been able to get along with two firemen.' The Western Transit Company, Buffalo, N. Y., which is using fifty-two of these blowers, writes as follows: I't does everything you claimed for it and keeps the flues and back heads clean. The operating is simple and easy. It does away with the frequent purchasing of steam hose and has a tendency to save coal. It takes only five minutes to clean the boiler.' "

Watertown automatic engines are described and illustrated in a catalogue issued by the Watertown Steam Engine Company, Watertown, N. Y.

Gate valves for steam and water, bent pipe work, tools and supplies of all kinds for steam, water and gas users are described in circulars distributed by the Walworth Manufacturing Company, 132 Federal street, Boston, Mass.

Pressure and vacuum gauges, ammonia gauges, pop safety valves, blow off valves, globe and angle valves, and other engineering specialties are illustrated and described in a folder issued by the Crosby Steam Gauge and Valve Company, 78 John street, New York city.

Specialties for steam and water users, such as shaking grates, boiler feeders, float valves, ball cocks, etc., are described and illustrated in a catalogue received from the F. W. Foster Manufacturing Company, No. 6 Portland street, Boston, Mass.

The Paulson pump cylinder reducing sleeve, manufactured by the Seattle Machine Works, Seattle, Wash., is described in a circular received from the company. This sleeve is designed especially for converting a standard steam boiler-feed pump into a high duty pump, and is said to be especially desirable on board ship, making it possible to change the regular boiler-feed pump to a test pump, using a low pressure donkey boiler for steam supply.

Books and things. "Number Two," is the title of an interesting and attractive booklet issued by the Derry-Collard Company, 256 Broadway, New York city, containing descriptions of various books on engineering subjects, and lists of many more. Mention is made of the Derry-Collard Book Club, a new plan which enables one to buy any books or papers wanted and to pay for them on the installment plan. Full description of this club plan can be obtained of the Derry-Collard Company by mentioning MARINE ENGINEERING.

Speed wheels are illustrated and described in a catalogue issued by the Michigan Motor Company, Grand Rapids, Mich. The catalogue states that the company's propeller wheels are accurately balanced, being designed by a naval architect, and are built of the best material. The company makes two and three blade reversible, and two and three blade solid wheels. Reversible friction clutch or transmission gears are also described in this catalogue. The clutch is claimed to be very powerful and easy to operate.

Packings for steam, air, ammonia and water are described and handsomely illustrated in a 140-page catalogue issued by the Garlock Packing Company, Palmyra, N. Y. This company has branch factories in Atlanta, Ga., Denver, Colo., San Francisco, Cal., and has stores and offices all over the United States, besides having a European factory and office at Hamburg, Germany. The first forty-two pages of the catalogue are devoted to ring packings for all purposes. Twenty-five styles of packings are illustrated in this section, and many more are described, including a metallic packing which the company has recently placed on the market, and which it states is the result of years of careful study. Pages 43 to 52 are devoted to spiral packings. Seven styles of spiral packing are illustrated, and several more are listed. Coil packing, with ten illustrations, is the subject matter of pages 53 to 72. Thirteen styles of sheet packing are described and illustrated in pages 73 to 82. Gaskets, pump valves, miscellaneous packings, diaphragms, valve disks, rubber belting, leather belting, lubricants, metal polish, and other specialties are described in the remainder of this catalogue, which every engineer should have, and which will be sent free upon application, to those mentioning MARINE ENGINEERING.

The second edition of *The Mariner's Guide,* published by H. Louderbrough, proprietor of the New Jersey Paint Works, Jersey City, N. J., has just been issued.

The January issue of "Graphite" is devoted especially to the subject of lubrication. This is a subject that interests almost every reader of MARINE ENGINEERING, and copies of this number can be had free by addressing the Joseph Dixon Crucible Company, Advertising Department, Jersey City, N. J.

CALENDARS RECEIVED.

The Broun-Green Company, commercial stationers, 38 Beaver street, New York city, a large wall calendar.

The Marine Manufacturing and Supply Company, 157 South street, New York city, a small desk calendar.

The Universal Safety Tread Company, 45 Broadway, New York city, a calendar calling attention to its safety tread for stairways, yachts, steamboats, etc.

The Morris Machine Works, Baldwinsville, N. Y., a handsomely lithographed calendar with a reproduction of a marine scene by Moran, entitled, "Solitude."

The Pope Manufacturing Company, 21 Park Row, New York city, a desk calendar with a leaf for every day in the year, and a "wise saw" on every leaf.

The Eastwood Wire Manufacturing Company, Belleville, N. J., a large wall calendar with a lithograph of the company's factory buildings.

The Climax Stationery Company, 29 Sullivan street, New York city, manufacturing stationers, lithographers and printers, a wall calendar giving the phases of the moon for the year.

The Cleveland Pneumatic Tool Company, Cleveland, Ohio. Two calendars handsomely lithographed in several colors, the subject of each being the head and bust of a young girl.

The A. W. Harris Oil Company, Providence, R. I., a calendar with the painting by Thos. Blinks, entitled: "The Thoroughbreds," lithographed in several colors.

William Bishop's Sons, 205 South street, New York city, manufacturers of marine plumbing, a calendar with a reproduction of Schurmann's painting, "A Surprise."

The Washington Trust Company, 280 Broadway, New York city, a calendar with blank spaces for memorandums for every day in the year.

The Falls Hollow Stayboit Company, Cuyahoga Falls, Ohio, a calendar with a reproduction in several colors of Peter Newell's painting, "A Promising Bite."

The Ross Valve Company, Troy, N. Y., a calendar consisting of a neat leather frame, with a card for every month. Attention is called to the company's feed water filters, regulating valves and water engines.

The Star Brass Manufacturing Company, 108 East Dedham Boston, Mass., a wall calendar with photographs of the company's pop safety valves, steam water and vacuum gauges, revolution counters, indicators and other engineering specialties.

The United States Metallic Packing Company, 429 N. 13th street, Philadelphia, Pa., a neat calendar which will be sent free to engineers upon request, showing a sectional photograph of the company's' Class No. 1 metallic packing, with key naming the parts.

The Baldt Anchor Company, Chester, Pa.; a handsome reproduction of a picture of a fleet of schooners rounding a point at night, lithographed in many colors.

The Diamond Drill and Machine Company, Birdsboro, Pa., manufacturer of cold saws, belt lacing machines, steel castings, etc., a large calendar with the well-known head of a girl by Philip Boileau, in several colors.

The Moran Towing Company, 10 South street, New York city, a calendar giving time of high and low tide at Sandy Hook, Governor's Island and Hell Gate, for every day in the year; also tide tables for some dozens of points on the Atlantic coast.

H. B. Underwood & Company, 1025 Hamilton street, Philadelphia, Pa., a large calendar suitable for hanging on the wall, calling attention to the company's portable cylinder boring bars, portable milling machines, and other machine tools.

Chas. C. Moore & Company, engineers and contractors, San Francisco, Cal., a calendar with a handsome map in several colors of the western coast of North America, which is stated to be the territory embraced by the business of the company.

The Ashton Valve Companv, 271 Franklin street, Boston, Mass., a calendar with a reproduction in several colors of a painting called: "Meet Me at the Bars," the subject being a young girl waiting at the bars of a country fence.

Stettiner Brothers, book and commercial printers, 52 Duane street, New York city, a wall calendar with a cover handsomely printed in several colors. Every day in the year has a space for memorandums, and in the back are smaller calendars for 1904, 1905 and 1906.

BUSINESS NOTES.

No more watch charms.—The Baldt Anchor Company, Chester, Pa., requests us to announce that its supply of watch charms in the form of a miniature anchor, is entirely exhausted.

"Northern" electrical generators.—The Tennessee Coal, Iron and Railroad Company, Birmingham, Ala., has given the Northern Electrical Manufacturing Company, Madison, Wis., an order for three 150 Kw. slow speed generators.

The Remy Electric Company, Anderson, Ind., reports that among the users of its magnetos are the following: The Samson Iron Works, Witte Iron Works, Hercules Gas Engine Works, A. W. Toppan, Winton Motor Carriage Company, Locomobile Company of America, and the Peerless Motor Car Company.

An efficient auxiliary engine.—The B. F. Sturtevant Company, Hyde Park, Mass., manufacturer of fans, blowers, and marine and stationary engines, states that "the rigid specifications drawn by the United States navy department for auxiliary engines required in the equipment of vessels of recent construction, have done much to improve their general standard of efficiency. It is therefore unusual to find that even these exceptional requirements have been improved upon. Such, however, is true in the case of recent designs of vertical cross-compound engines built by us for direct connected generator driving. These engines have shown upon an economy test, a consumption of steam per horse power four pounds less than that demanded by the specifications. This result is characteristic of a line of engines we are building to develop from 25 to 150 H. P."

Removal notice.—Philip Braender, manufacturer of the Braender bilge syphon, has removed from 63 W. 125th street, to 143 W. 125th street, New York city.

Mr. Maurice E. Baird, with headquarters in Minneapolis, Minn., will represent the Eureka Fire Hose Company, 13 Barclay street, New York city, in Iowa, Northern Wisconsin, Minnesota, North and South Dakota and Montana. Mr. Baird has been connected with the Eureka Fire Hose Company for some years, having, together with his brother, represented the company in Chicago.

Mr. E. S. Lea has resigned as sales manager of the De Laval Steam Turbine Company, Trenton, N. J., and has opened an office at 42 Broadway, New York city, as consulting engineer. Mr. Lea is a member of the American Society of Mechanical Engineers, and an associate member of the American Institute of Electrical Engineers, and of the American Society of Naval Engineers.

Largest electrical generators in the world driven by gas engines. The Crocker-Wheeler Company, Ampere, N. J., has received from the California Gas and Electric Corporation, San Francisco, Cal., an order for three 4,000 Kw., three phase, 13,200 volt, 25 cycle, 88 R. P. M., revolving field, alternating current generators, to be driven by 5,400 H. P. gas engines. The plant will furnish power for operating all the street railways in San Francisco and vicinity.

The National Exhibition of engine and boat manufacturers, in conjunction with the Sportmen's show, will be held at Madison Square Gardens, New York city, February 21, to March 9. Most of the leading makes of motors, engines, and accessories, with the finest models of boats yet produced, will be on exhibition. On the main floor will be the lagoon, which is said to be the largest artificial indoor lake, and on this lake the boats will be exhibited. This will be a great opportunity for those interested in motor boats to see the leading makes in motion.

Almy water tube boilers.—The Almy Water Tube Boiler Company, Providence, R. I., among other orders for water tube boilers during 1904, received the following: one boiler for the steam yacht *Katrina,* of Hartford; one for the tug *Howell,* of Providence; one for the Peruvian goverment disinfecting boat; two for W. D. Forbes Company, Hoboken, N. J., to be placed on gold dredges for use in South America; one for the steamer *Sagamore,* of the Newport and Providence Railway Company, and two boilers for the Peary Arctic Club exploration ship.

Albany grease spindle cup.—This cup, which is made by Adam Cook's Sons, 313 West street, New York city, may be readily attached to the bearing by any machine. A hole through the cap and brass is bored, of sufficient size to allow the outside tube of the cup to enter the inside spindle coming into contact with the shaft. The outside tube, being shorter, will clear the shaft by from one-fourth to three-eighths of an inch. The inside spindle is then removed, the cup filled and the spindle replaced, when the apparatus is ready for use. It is claimed that the most obstinate bearing will yield when Albany grease is used, whether on slow or fast running machinery.

The Submarine Signal Company, 247 Atlantic avenue, Boston, Mass., has received the following letter from Benj. S. Grove, master of the steamship *James S. Whitney:* "We left New York Saturday, Dec. 5, and when running for Pollock Rip Shoals we heard the submarine bell on the lightship at the point a distance of about eight knots over all shoals and tide rips. The bell sounded clear and distinct. We next tried for bell coming up to lightship 54 in Boston bay. When forty-five minutes away, or at a distance of eleven knots, we first heard the submarine bell and it sounded clear and fairly strong. When forty minutes away, or at a distance of ten knots, there was no trouble in getting a strong, clear bell tone, and it could be distinguished by anyone.

Some successful advertising.—The original methods of advertising the wares W. S. Rogers wants to market, are well known to every reader of a mechanical journal. The picture of his little baby girl on the catalogue of the old Ball Bearing Company, of Boston, was a trade winning scheme, says Mr. Rogers, that built up that company from an unknown quantity to a valuable selling proposition, and his "big stick" and the rats he says, helped him to dispose of the most worthless lot of stock a man ever got loaded up with. But his rooster hatching out ball bearings in the advertising of the Bantam Manufacturing Company has been the prize winner of all. Thousands of letters from all parts of the earth have been received by the company during the past two years advising it that "the rooster is not a bantam at all," which was exactly the thing that Mr. Rogers wished to accomplish. But that the idea went beyond Mr. Rogers' aims was shown by a letter recently received from Austria which read as follows: "Will you please send us your prospectus concerning your incubators and brooders with discounts for foreign sale as by your advertisements. Yours truly, J. Swartz & Co."

NAVAL ARCHITECTURE is taught by correspondence by the Grand Rapids School of Mechanical Drawing, 361 Houseman Building, Grand Rapids, Mich. The company states that it is the only correspondence school offering this course of instruction.

LONG RUN OF A STEAM TURBINE GENERATING UNIT.—The 600 H. P. Westinghouse steam turbine generating unit in the Palace of Machinery, at the World's Fair, St. Louis, was shut down on December 2, after a continuous run of five and one-half months, while maintaining a speed under load of 3,600 revolutions per minute. The engine was found to be in perfect condition, without a trace of wear.

FALLS HOLLOW STAYBOLTS.—The Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio, has received an order from the Baldwin Locomotive Works for several thousand feet of double-refined charcoal iron hollow bars for use on locomotives the company is building for a railroad in Brazil. The Falls Hollow Staybolt Company has built a large addition to its factory during the past year, has installed new water wheels, erected new furnaces, and made other improvements which double the capacity of its plant.

ANTI-FOULING PAINT.—The Hertzog Paint and Varnish Company, 627 Cherry street, Philadelphia, Pa., has received the following letter from Captain N. B. Watson, of the yacht *Constellation*, Beverly, Mass.: "May 24 I received a half gallon of your red anti-fouling paint as a sample with my order of cement paint, and applied it to the rudder of yacht *Constellation*. On Sept. 29 we hauled out and after being on all season, I found your paint clean and smooth. The paint looked good and fresh, not having cracked or peeled off. In my experience, what little I have used of your red paint has given the best satisfaction of any I have ever used. There is nothing I have ever used as good for a steel vessel, as Hertzog's cement paint to prevent rusting. I have used it on the yacht *Constellation* for the last twelve years."

MARINE ENGINEERING
EMPLOYMENT BUREAU

Full information regarding the purposes of this Bureau, together with instructions regarding registration, etc., furnished upon application to MARINE ENGINEERING Employment Bureau, 17 Battery Place, New York city.

All correspondence, concerning either vacancies or situations wanted, is strictly confidential.

POSITIONS SEEKING MEN

DREDGE DESIGNER AND BUILDER wanted; one who has the necessary knowledge and experience to connect himself with a well-known dredge-building concern. File No. 47.

FOREMAN FOR BOAT BUILDING SHOP who has had experience in constructing new hulls, who can attend to repair work and is familiar with gas engines. File 15.

GAS ENGINE BUILDER wanted to combine his business with a boat building and repairing shop which has marine railways and an established business. File 40.

SHEET IRON WORKERS, erecting machinists, and steam fitters wanted who have had experience in marine work. File No. 42.

SKILLED BOAT BUILDER who has had experience in handling men, and who can attend to the hull work in large launch works. File 14.

STEAMFITTER AND COPPERSMITH acquainted with plumbing, and able to make estimates; also to take charge in a general way of plumbers, coppersmiths and steamfitters. File No. 36.

SUPERINTENDENT OF BOILER DEPARTMENT wanted in well known shipyard; must be capable of figuring costs in both repair work and new work; give full experience and references. File No. 45.

YACHT AND BOAT BUILDER wanted who understands inside joiner work and who is able to superintend the building of launches and yachts under all the branches. File No. 39.

We have applications registered for positions as follows, and the references of each applicant have been carefully investigated:

MEN SEEKING POSITIONS

We have applications registered for positions as follows, and the references of each applicant have been carefully investigated:

ASSISTANT SUPERINTENDENT, ENGINEER OR ASSISTANT ENGINEER IN ENGINEERING WORKS. Age 28; single; of English birth; has British and American licenses and has had several years' sea experience. Application No. 23.

BOILER-MAKER FOREMAN seeks position. Is at present foreman of rail-road shops and has charge of nearly one hundred men; has had twelve years' experience as foreman; posted in the latest boiler practice; has best references as to ability and character; is 38 years old. Application No. 73.

BOILER-SHOP FOREMAN. Age 35; single; many years' experience in Navy Yard and leading shipyards. Application No. 59.

BOILER-SHOP FOREMAN. Age 37; single; 16 years' experience in boiler-shop work. Application No. 47.

CHIEF OR ASSISTANT CHIEF DRAFTSMAN—ENGINE. Age 33; married; has had sea experience and thirteen years as leading and chief draftsman of private and government shipyards. Application No. 25.

CONSULTING ENGINEER AND NAVAL ARCHITECT. Married; born in Germany; had many years' experience in designing, drafting and surveying. Application No. 33.

DESIGNER AND DRAFTSMAN. Has had many years' experience in launch and river boat work. Designed some of the fastest river boats in the country. Application No. 61.

DRAFTSMAN, ENGINE AND BOILER. Age 30; unmarried; has Danish marine license; technical school graduate. Application No. 57.

DRAFTSMAN—HULL. Age 20; single; experienced in architectural work, but prefers marine drafting. Application No. 51.

DRAFTSMAN—HULL. Age 25; married; 9 years' experience in leading yards in drafting, testing materials, surveying, etc. Application No. 54.

DRAFTSMAN—HULL, OR INSPECTOR. Age 37; married; had experience both in government yards and private yards. Application No. 30.

DRAFTSMAN—HULL. Age 22; single; born in Norway; studied Technical schools in Norway and Germany; experience as draftsman, also as shipfitter. Application No. 31.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

12 West 31st Street, New York.

President, FRANCIS T. BOWLES.
Secretary-Treasurer, W. J. BAXTER.
Executive Committee, LEWIS NIXON, EDWIN A. STEVENS, HARRINGTON PUTNAM, STEVENSON TAYLOR. *Ex-officio*, FRANCIS T. BOWLES, W. J. BAXTER.

AMERICAN SOCIETY OF NAVAL ENGINEERS.

Navy Department, Washington, D. C.

President, Commander A. F. DIXON, U.S.N.
Secretary-Treasurer, Lieutenant CHARLES K. MALLORY, U.S.N. (retired.)
Council, Captain GEORGE W. BAIRD, U.S.N.; Commander J. K. BARTON, U.S.N.; Commander W. M. PARKS, U.S.N.

MARINE ENGINEERS' BENEFICIAL ASSOCIATION.

National President, FRANK A. JONES, 1959 Eddy St., San Francisco, Cal.
Vice-President, CHARLES W. ROBINSON, 908 G. St., N. W., Washington, D. C.
Second Vice-President, EVANS I. JENKINS, 153 Clinton St., Cleveland, Ohio.
Secretary, GEORGE A. GRUBB, 1318 Wolfram St., Lake View, Chicago.
Treasurer, ALBERT L. JONES, 289 Champlain St., Detroit, Mich.
Advisory Board, WILLIAM F. YATES, 120 Liberty St., New York city; GEORGE F. KEATING, 74 Webster St., East Boston, Mass.; W. D. BLAICHER, 10 Exchange St., Buffalo, N. Y.

ADDRESSES OF CORRESPONDING SECRETARIES.

No. 1, W. D. Blaicher, 10 Exchange St., Buffalo, N. Y.
" 2, Wm. Kelly, 11 Wall St., Cleveland, O.
" 3, A. L. Jones, 289 Champlain St., Detroit, Mich.
" 4, James A. Macauley, 5802 Indiana Ave., Chicago, Ill.
" 5, Otto Boettger, 1035 E. Hopkins Ave., Baltimore, Md.
" 6, Wm. Arste, 322 Pine St., St. Louis, Mo.
" 7, Wm. T. McElwee, Box 1556, Portland, Me.
" 9, Wm. Bridges, 784 1-2 12th St., Milwaukee, Wis.
" 13, John G. Paulding, 1746 Tulip St., Philadelphia, Pa.
" 14, Joseph F. Dumas, 403 Dauphin St., Mobile, Ala.
" 15, R. L. Skinner, 622 Louisa St., New Orleans, La.
" 17, Jas. D. Robinson, 6th and Columbia Sts., Newport, Ky.
" 18, Wm. Hurst, 715 Walnut St., Cairo, Ill.
" 20, Jos. B. Barry, 206 Keel St., Memphis, Tenn.
" 21, J. H. Foley, 206 N. Mulberry St., Vicksburg, Miss.
" 23, Wm. R. Lewis, 213 E. Front St., Jeffersonville, Ind.
" 24, Hugh L. Edwards, 511 Washington St., Paducah, Ky.
" 26, T. H. Kirkbridge, 228 Bond St., Evansville, Ind.
" 27, L. C. Schwall, 598 S. Madison St., Bay City, Mich.
" 29, James R. Sutherland, Charleston, W. Va.
" 30, E. R. Humphrey, 21 State St., Pittsburg, Pa.
" 33, James J. Waters, 283 Hudson St., New York, N. Y.
" 35, William M. Coombs, 36 East St., San Francisco, Cal.
" 36, Jos. Thomas, 57 Sea St., New Haven, Conn.
" 37, John B. Bender, 1215 Evesham Ave., Toledo, Ohio.
" 38, C. H. Wolford, 73 Starr Boyd Bldg., Seattle, Wash.
" 39, Frank Feeney, 460 E. 12th St., Erie, Pa.
" 40, Chas. Drouet, 1003 Ave. I, Galveston, Tex.
" 41, W. H. Marshall, 343 Holladay St., Portland, Ore.
" 42, Jas. Manning, 802 E. Duval St., Jacksonville, Fla.
" 43, A. J. Wilson, 1327 La Peer Ave., Port Huron, Mich.
" 44, Chas. J. Sullivan, 480 1st St., Manistee, Mich.
" 45, W. L. Salter, care O. S. S. Co., Savannah, Ga.
" 46, D. W. Farrell, Clayton, N. Y.
" 47, J. R. Cook, Sault Ste. Marie, Mich.
" 48, Alfred Hegemer, 140 E. Park St., Sandusky, O.
" 51, H. S. Connell, 12 Ranson St., Muskegon, Mich.
" 53, Harry Stone, Box 445, Marine City, Mich.
" 55, Archie Stalker, Box 883, Cheboygan, Mich.
" 57, E. B. Meeker, 71 Abeel St., Kingston, N. Y.
" 58, E. Capers Haselden, Box 31, Georgetown, S. C.
" 59, George F. Keating, 74 Webster St., E. Boston, Mass.
" 62, N. S. Lawrence, 30 Connecticut Ave., New London, Conn.
" 63, M. J. Burke, 152 Sheridan Ave., Albany, N. Y.
" 65, W. C. Palmer, care Consumers' Coal Co., Charleston, S. C.
" 67, James K. Dole, Saugatuck, Mich.
" 70, Charles T. Smith, 665 Commercial St., Astoria, Ore.
" 72, Wm. T. Findlay, 130 W. Bridge St., Oswego, N. Y.
" 73, E. M. Donahue, 1308 Cherry St., Green Bay, Wis.
" 75, Wm. D. Hemenway, Alexandria Bay, N. Y.
" 76, Orson Vanderhoef, Grand Haven, Mich.
" 77, John P. Hall, 1215 Huron St., Manitowac, Wis.
" 78, J. P. Burg, 2722 Minnesota Ave., Duluth, Minn.
" 80, Edward S. Welch, 338 Hamilton St., Albany, N. Y.
" 81, Jas. L. Sweeney, 206 E. Sarragosa St., Pensacola, Fla.
" 82, Fred H. Gowell, 427 Middle St., Bath, Me.
" 85, John A. Packard, 623 Merchant St., Alpena, Mich.
" 86, Sherman A. Smith, 737 Menekaunee Ave., Marinetta, Wis.
" 87, George B. Milne, 809 Fourth St., Detroit, Mich.
" 88, C. O. Chapman, S. B. Canal, Sturgeon Bay, Wis.
" 89, Geo. E. Willard, 4 Isabella St., Ogdensburg, N. Y.
" 91, A. L. McLaren, 130 W. Walnut St., Ashtabula, O.
" 92, Jos. D. Budd, Box 50, Sta. I, Saginaw, W. S., Mich.
" 93, W. J. Cook, 2220 G. St., N. W., Washington, D. C.
" 94, George R. Jones, Box 222, Washington, N. C.
" 95, P. J. McMahon, Box 199, Key West, Fla.
" 98, C. N. Vosburg, 6323 Patton St., New Orleans, La.
" 100, H. F. Mocine, Honolulu, H. I.
" 101, J. K. Cotton, Box 765, Norfolk, Va.
" 102, Fred. W. Linsemeyer, 210 Clinton St., South Haven, Mich.
" 103, A. E. Pittman, Box 378, New Bern, N. C.

TRADE PUBLICATIONS.

Bulletin No. 1061, issued by the Fort Wayne Electrical Works, Fort Wayne, Ind., describes and illustrates multiphase induction integrating type K watt-meters.

"Eighty cents per year will pay the cost of maintenance and repairs of the Williams steam frap," says a mailing card issued by the Williams Gauge Company, Pittsburg, Pa. The trap is said to be positive and with the ability to handle a large amount of water.

The Pilley Packing and Flue Brush Manufacturing Company, 606 South Third street, St. Louis, Mo., is mailing a folder describing Pilley's combination flue brush and scraper. This folder also describes flue brushes of various sorts, flue scrapers, steam tube cleaners, flue cleaner rods, boiler brushes, and brushes for various other uses.

Cook's Metallic Packing is attractively described in a booklet issued by C. Lee Cook, M.E., Louisville, Ky. This packing is entirely metallic and steam adjustable, and it is said never wears a rod. It has very few parts and but one wearing part—the sectional babbitt ring—which it is claimed is so durable and so cheap that the cost of the packing does not exceed 10 cents per inch diameter of rod per year.

Lord's List of Trade Papers, published by the Lord Advertising Agency, Connell building, Scranton, Pa., is now ready for distribution. The directory has been prepared for free distribution among present and prospective advertisers, and also for the purpose of advertising the facilities of the Lord agency for writing and printing technical catalogues and other trade literature. Publishers are asked to advise the agency of any errors in the list, and also as to changes in rates, circulation, etc.

The preservation of ships by electrically operated doors and hatches of the "Long-Arm" system, is the subject of Bulletin No. 10, issued by The "Long-Arm" System Company, Cleveland, Ohio, which will be sent free upon application. In addition to the power doors and hatches described therein, this company manufactures navy standard ship fittings, including swinging doors, coal-bunker trimming doors, man-holes, air ports, dead-lights, deck-lights, magazine light boxes, hand-pumps, and forgings for water-tight hatches.

Boiler shop and shipbuilders' tools are the subject of a catalogue issued by Wickes Brothers, Saginaw, Mich. This firm was established in 1860, and has built some of the largest marine boilers on the Great Lakes. Among the machine tools described and illustrated in this catalogue are heavy duty rolls with balance bar, horizontal bending rolls, light shipbuilders' rolls, medium duty rolls without balance bar, heavy duty rolls showing application of an electric motor, vertical rolls, punches and shears, flanging clamps, hydraulic flanging presses, and portable hydraulic riveters.

"The Valve World" is the title of a handsomely printed and illustrated magazine published by Crane Company, Chicago, Ill. Volume I, No. 1, has just appeared, and the scope of the magazine may be seen by the subjects treated in the initial number, viz.: "Brief History of the Crane Company," "Exhibit at the Louisiana Purchase Exhibition," "The Vanderbilt Cylindrical Locomotive Tender," "Improvements in Pop Safety-Valves of Special Interest to Engineers," "Introductory of The Valve World," "Business Integrity," "History of Making Wrought-Iron Pipe," "Making Wrought-Iron Pipe by Electricity," "Steamship Minnesota," "Humidity of Artificially Heated Rooms," "Malleable Iron Flanges for Steam Pipe," "St. Regis Hotel," "A Handsome Lavatory," "Bending Cast-Iron Pipe," "Trade News." It is intended to issue The Valve World monthly, and copies will be sent free upon application to readers of MARINE ENGINEERING.

Automatic and auto-positive injectors, ejectors, and steam jet-pumps, force feed-lubricators, oil and grease cups, high- and low-water alarms, gauge-cocks, etc., are illustrated and described in 64-page catalogue No. 21, issued by the Penberthy Injector Company, Detroit, Mich. The catalogue states that the Penberthy injector has been too long on the market and is too familiar to the steam user and the steam supply trade to require any introduction. The auto-positive injector, so the company states, while less familiar, has been on the market several years, and has won recognition for its reliability under extreme conditions, while retaining simplicity of construction. By an arrangement of the overflow valves, it will work on higher pressures and handle hotter water than the Penberthy automatic. The company recommends the auto-positive injector for pressures of 140 pounds and upwards, or where the temperature of the water supply is above 110 degrees. For all other conditions the company recommends its automatic injector. In the catalogue is some useful information entitled "Some Facts to be Considered in Selecting an Injector." Engineers will find it to their interest to send for a free copy of this catalogue.

The Brown & Sharpe Manufacturing Company, Providence, R. I., is mailing its 1905 catalogue of machinery and tools. This catalogue, which has been thoroughly revised, contains 496 pages. It contains a large number of tables and general information, making it valuable to the workman as a book of reference. It will be mailed free of charge to anyone mentioning MARINE ENGINEERING.

Ball and roller bearings are the subject of a 64-page illustrated catalogue issued by the Standard Roller Bearing Company, 48th street and Girard avenue, Philadelphia, Pa. The company states that it owns and controls more than one hundred patents covering ball and roller bearings, as well as methods, processes, and machines used in making same.

Friction joint calipers, made with Cook's new beeswax joint, are illustrated and described in a folder issued by the Sawyer Tool Manufacturing Company, Fitchburg, Mass. The folder states: "The problem of properly applying beeswax to a caliper joint in a manner so that the beeswax is retained for an indefinite period, whether the tool is constantly or only occasionally used, has been successfully solved by this invention. The pockets for holding the beeswax are made in such a manner that they do not impair the utility of the joint, but rather add to it. They have that firmness of feeling so much desired by every mechanic."

Silent running high-speed chains are illustrated and described in Catalogue No. 7, issued by the Morse Chain Company, Trumansburg, N. Y. The catalogue states that for the past two years Morse silent chains have been in successful operation at speeds up to 2,000 feet per minute. "This form of transmission is compact, silent, durable, exceptionally efficient, and has a wide range of application. The Morse silent chain joint is an application of a principle new in chain construction. It has long been recognized that a rocking action between hardened steel surfaces is a perfect means of obtaining motion of parts which swing or turn upon each other through a limited angle—the precise function required in the chain. Such a joint is almost indestructible, even under enormous pressure, requires no lubrication and involves no perceptible friction or wear. In addition to all the advantages derived from this frictionless joint construction, the Morse high-speed chain also fully utilizes the silent running and compensatory features as embodied in the best modern practice."

Steam regulating devices and steam pumps, manufactured by the Mason Regulator Company, 158 Summer street, Boston, Mass., are described in a 50-page catalogue. Regarding the Mason reducing valve, the catalogue states "this valve is designed to reduce and maintain an even steam or air pressure, regardless of the initial pressure. It will automatically reduce boiler pressure for steam-heating coils, and all places where it is desirable to use lower pressures than that of the boiler. The dash-pot, which immediately fills with condensation, prevents all chattering or pounding, and requires no attention. No extra lock-up attachment is needed, as the pressure is regulated by a key, which the engineer retains. The sizes, up to and including 2-inch, are made of the best composition, and above that, of cast iron, with composition linings. In the larger sizes the composition lining is hung up in the valve, leaving a space between the iron and composition for the unequal expansion of the metals; thus there is no possibility of the piston sticking when the valve is heated. The area of the passage from the high- to the low-pressure side of the valve is equal, when open, to the full area of the pipe, so that a low pressure of the system, almost equal to the initial high pressure, may be carried. To increase pressure, turn the key in the direction taken by the hands of a watch."

Wood finishers' supplies, leads, colors, paints, varnishes, etc., are the subject of a 36-page catalogue published by the Adams & Elting Company, 155 Washington Boulevard, Chicago, Ill.

Eccentric fittings are illustrated and described in a booklet received from W. F. Swadkins, 145 Fulton street, Chicago, Ill. This company manufactures screwed and flanged fittings (eccentric and specials), cast-iron and steel saddle flanges, valves, pipes, etc.

Wrought bar parallel-swivel vises are described in a pamphlet issued by Merrill Brothers, Brooklyn, N. Y. These vises have extra heavy jaws that cannot be broken with a hand hammer. Over 300 of them are said to be used in the Baldwin Locomotive Works. This company also manufactures one-piece, drop-forged turn-buckles, eye-bolts, etc.

"W. & B. Universal Self-Oiling Drills" are described in a circular issued by The Whitman & Barnes Manufacturing Company, Chicago, Ill. The oil is conducted to the tube, either from an elevated reservoir or a pump, and is forced to the point of the drill, flooding it, and assisting in the removal of the chips.

Automatic lubricators, chain pipe-wrenches, reversible ratchet-wrenches, belt couplings, self-lubricating plumbago packing, and other engineers' specialties, are illustrated and described in a 64-page catalogue issued by Greene, Tweed & Company, 17 Murray street, New York city.

"Diamond" marine gasoline engines are illustrated and described in a catalogue published by the H. A. Heinel Company, Wilmington, Del., which states that "our engines have been designed for moderate speeds, high efficiency, long life, medium weight, and smooth running, and they have fulfilled all our expectations. We are also prepared to design and build special light-weight engines for racing purposes to order. Our standard engines are fitted with solid one-piece, steel-forged, crank-shafts, specially adapted to the work they have to perform. Special attention is called to the manner of attaching the fly-wheels to the crank-shafts. The end of shaft to which the wheel is fastened is turned to a standard taper with the extreme end chased with standard thread to receive the large nut which is used to force the fly-wheel on. The fly-wheel is bored taper and reamed with standard reamer, key-seated, and when forced upon the shaft with the large nut, insures an absolutely tight fly-wheel. The fly-wheel also has holes drilled in the web or spokes which are tapped to receive standard bolts, so that the wheel may be drawn off in a few minutes. This does away with breaking the heads off of keys and drilling out broken keys, an occurrence that often happens with the old methods. There are special holes in the periphery of the fly-wheel for inserting the starting bar. The engine can be started with or without the bar, at the pleasure of the operator."

"Pipe and Boiler Coverings and their Uses" is the title of an illustrated booklet issued by the H. W. Johns-Manville Company, 100 William street, New York city. Engineers interested in the subject should send for a free copy of this booklet.

Reversible marine gasoline engines. Termaat & Monahan, Oshkosh, Wis., builders of two- and four-cycle marine gasoline engines, are distributing a handsome 28-page catalogue illustrating and describing their 1905 engines. The catalogue states: "We take especial pride in the design of our engines. They are symmetrical and well-balanced throughout. The fly-wheel is neither too light nor too heavy. The cylinder and head are cast in one piece, obviating any chance of leakage. The center of gravity is low, the engine being supported on the foundation near the center line of the shaft. Our improved muffler, which is attached to all our single-cylinder engines, has a number of valuable features."

Air and gas compressors.—The Rand Drill Company, 128 Broadway, New York city, has issued the fourth edition of Catalogue "C," which describes many sizes of the various types of steam (Corliss, Meyer, and plain), belt, gear, and chain-driven compressors, and includes articles on water impulse and sectional machines. There are many half-tone cuts showing the construction of the Rand standard and special compressor. The catalogue also contains articles of a semi-technical character which explain the phenomena attending the compression and expansion of air; also a number of tables of value to those interested in the study of air compression. A copy will be sent free upon request.

Stamped steel boats, manufactured by the W. H. Mullins Company, Salem, Ohio, are described in an illustrated 48-page catalogue. The catalogue states: "We build boats for pleasure or for business. We don't make them of wood. We make them of steel. Our boats do not oxidize, they do not leak, they do not wear out, they do not buckle, and they do not sink. They are smooth skinned. They have few joints and are built in plates like warships. Instead of being clinker-built they are carvel-built. There are no lap-strake joints, no starting seams, and no caulking. Each boat has its plates pressed into true shape by dies. Every boat on the same die is made alike. In all our boats is an air-tight compartment. Our boats even when upside down will not sink. These air-tight compartments may be the means of saving your life and that of your family. Foot for foot, one of our boats weighs no more than a clinker-built wooden boat, and it will outwear a dozen such boats."

"Our steam steering-gear," says a folder issued by the Dake Engine Company, Grand Haven, Mich., "has been designed to meet the wants of tug and vessel owners for a light, compact, and efficient machine for pilot-house service. It consists of two standards on a flat base, supporting a shaft carrying a chain wheel for rudder-chain, and also a hand steering-wheel. This steering-wheel shaft carries also a gear which is driven by pinion on the engine shaft. The engine is made to stop, start or reverse by means of a lever connected to the hand-wheel, which is not keyed to the shaft, but revolves loosely on same, and it requires a slight movement of the hand-wheel to port or starboard to start or stop the gear at any point. The gear may be changed from steam to hand-power in a few seconds. The gear is equipped with an automatic closing device, and with a hand-lever attached to the throttle valve. It is optional for the pilot to use this lever of the hand-wheel for steering. An indicator shows the position of the rudder at all times."

The Marck steam trap is the subject of No. 1, Vol. II, of *The Houghton Brief*, "a periodical devoted to industrial supplies," published by E. F. Houghton Company, 240 West Somerset street, Philadelphia, Pa. The paper says: "The Marck steam trap depends upon neither floats, weights, balances, springs, counter balances, pet cocks, air cushions, or metal expansion, but solely upon temperature. We will send to any reliable person from one to ten traps, with the understanding that they can be returned at the end of thirty days if not satisfactory, and we will cancel the charge in full."

"Air Power," Vol. I, No. 1, issued by the Rand Drill Company, 128 Broadway, New York city, has been sent to us for notice. The editorial announcement states that the magazine will be issued quarterly, the object being to keep in touch with compressed-air users, and to educate them to feel that they may call upon the Rand Drill Company whenever they wish to ask questions or discuss any subject pertaining to the uses of compressed air. Among the articles in the first number of the new publication is a paper by J. B. Carper, M.E., which was read before the Mechanical Engineers' Association, Witwatersrand, South Africa, on "Trials of Rock Drills." The magazine is handsomely illustrated, and, we infer, will be sent free to applicants mentioning MARINE ENGINEERING.

Tools and supplies for steam, water, and gas users are profusely illustrated and concisely described in a 352-page, cloth-bound catalogue issued by the Walworth Manufacturing Company, 128 Federal street, Boston, Mass. In order to show how complete a catalogue this is, we give the subjects of the various divisions by page numbers: cast iron and malleable pipe fittings, 16 to 77; flanged fittings, pipe bends, brackets, and floor stands, 78 to 101; standard brass and iron valves and cocks, 102 to 131; special brass and iron valves and cocks, 132 to 161; engine and boiler trimmings, 162 to 189; Walworth injectors, pop safety-valves, steam-gauges, 190 to 203; steam fitters' and engineers' tools, 204 to 241; water work and hose goods, 242 to 277; steam and hot-water apparatus, 278 to 295; Walworth electric railway brackets, and Walworth gas machines and mixers, 296 to 317; miscellaneous goods and index, 318 to 352.

Marine gasoline engines are described in a handsomely illustrated catalogue issued by the Standard Motor Construction Company, 172 Whiton street, Jersey City, N. J. The catalogue states "the Standard is an internal combustion motor operating on the well-known four-cycle principle, and uses gasoline for fuel. In operation, the downward stroke of the piston draws a charge of gas and air into the cylinder, which the first upward stroke compresses into a clearance above the piston. While the piston is at the top of the stroke, the mixture is ignited by a spark, and the resulting expansion of the gases drives the piston down; the return stroke discharges the burnt gases from the cylinder, and so permits of an automatic continuance of the operation. The principle of operation of these engines is the same as in all large engines of the stationary type, and has proved the most successful principle. Our engines, while running under full load, consume one pint of gasoline per hour for each horsepower developed. When slowed down and not required to develop their full power, the automatic governor proportionately reduces the consumption of fuel. The larger sizes consume about one gallon in 10 hours per horsepower. In the methods of installation and in the operation, the Standard is absolutely safe, no fire of any kind being required in the operation or starting of the engine while the fuel is handled in such a way as to be absolutely free from the escape of gases. Through the use of the starting lever, the ignition timing lever, but one release lever for all cylinders, the automatic governor, the easy-working reverse lever, and the accessible igniter, the Standard is a most conveniently handled engine. Accessibility is one of the main features of the Standard. Every part can be instantly inspected and cleaned with ease when required, and should any small parts have to be removed, it does not necessitate taking the whole engine to pieces. The speed may be instantly changed without altering the mixture. The time of ignition may be varied in all cylinders with but one lever. The automatic vaporizer does not require adjusting for any variation of speed, nor any regulation of the air supply. Among other advantages are the following: Varying speeds may be attained by means of the automatic governor. Supply valves have air cushions. Reverse gears run in oil-tight gear case. The starting and reverse lever is easily operated. All parts are subjected to positive lubrication. The engine is smooth-running and free from vibration. The exhaust is noiseless and free from excessive heat. One man can handle the boat from the pilot house, owing to the easy operation of the reverse lever and the automatic governor. Positiveness in starting of engine. Positiveness in the operation of the engine. Large margin in power above the amount rated."

The various uses of graphite.—The Joseph Dixon Crucible Company, Jersey City, N. J., is a prolific publisher of booklets describing the various uses of graphite. Among the books the company has published, and which will be sent free to readers of MARINE ENGINEERING, are the following: "Graphite as a Lubricant," "Oil vs. Grease," "Dixon's Graphite Suggestions," "The Manufacture and Care of Plumbago Crucibles," "Graphite Afloat and Afield," "Running Steam Cylinders Without Oil," "Dixon's School Pencils," "Dixon's Index for Pencil Users," and "Pencil Geography."

Lacy marine gasoline engines, built by the Brown-Cochran Company, Lorain, Ohio, are illustrated and described in a catalogue recently issued. This catalogue states that the Lacy engines "are built in many sizes in both the two-cycle and the four-cycle types. Each type has its points of advantage, depending upon the service for which it is to be used. We recommend the two-cycle for one type of boat and the four-cycle for another. The type of boat and the individual requirements of the purchaser determine, to a great extent, the type of engine. We do claim that well-designed engines of either type are equally reliable. Many intending purchasers in looking over our catalogue will be able to determine for themselves the type of engines best suited to their needs. If in doubt in this regard we shall be glad to offer suggestions based upon our wide experience. We use nothing but the best of material in all parts of our engines. Iron castings are of the best grade of close gray iron. Not a cylinder or piston casting passes inspection if it shows the slightest imperfection either before or after machining. All bearings are of the best phosphor bronze, as are also the connecting rods of the smaller size engines. Crankshafts are forged from the solid of the best mild steel. Machining is done in our special fixtures, insuring perfect accuracy. Here again we use the greatest care. Pistons are carefully turned slightly smaller at the top where subjected to the greatest heat, obviating the possibility of sticking in the cylinder. Piston rings are first turned, then square cut, then sprung together, and again turned accurately to the size of the cylinder. This process insures a perfect fitting and gas-tight ring. In all sizes 5 horsepower and larger we do not spring the rings over the head of the piston. They are merely slipped over and retained by a follower-plate which covers the head of the piston."

"A New Line of Variable Speed Motors" is the subject of "Flyer No. 253," issued by the Crocker-Wheeler Company, manufacturers and electrical engineers, Ampere, N. J.

Economy in the boiler room. The William B. Pierce Company, 321 Washington street, Buffalo, N. Y., has issued a booklet entitled "Economy in the Boiler Room," which is valuable to those interested in the economical handling of the fuel problem. This booklet deals with the causes of boiler scale and its remedy. The remedy given is the Dean boiler-tube cleaner, a mechanical cleaner which is said to have 6,000 users throughout the country, and which has been adopted, it is stated, almost universally by large corporations, the United States Steel Company using over 100, the Standard Oil Company 50, the American Writing Paper Company 14, etc. Marine engineers will do well to send for the booklet, which will be sent free to those mentioning MARINE ENGINEERING.

Sailing boats, gasoline launches, and row boats of every description, marine gasoline engines, and boat equipments of all kinds, are illustrated and described in a 32-page catalogue issued by Fred. Medart, 3530-3545 De Kalb street, St. Louis, Mo. The catalogue especially calls attention to Mr. Medart's system of supplying boat-building materials. Many testimonials appear wherein customers express their satisfaction with boats and materials purchased. The following letter written by Mr. John Kane Mills, Lawrence, Long Island, N. Y., will do as a sample: "The materials for the *Swallow,* a 24-foot racing sloop, arrived in good condition and were easily put together. Each piece was plainly marked and fitted exactly, and although I had no previous experience, I had no difficulty in building the boat. Boat builders asked me from $280 to $325 to build a *Swallow,* and with your materials I built and fully equipped her for $129.67, freight on materials included. I had no professional help, and found the lumber to be well planed and without a knot, split, or flaw. I put the materials together and painted the boat in thirty-four hours. Your materials bring boat-building within the range of amateurs and enable people of moderate means to secure a first-class boat." A copy of this catalogue will be sent free to every person mentioning MARINE ENGINEERING.

A "Treatise on Mechanical Draft" has been published by the B. F. Sturtevant Company, Hyde Park, Mass., which will be found of interest and value to those interested in that subject. The following are extracts from that work: "One of the features of the advent of electrically driven machinery has been the development of the electric fan. Originally the pulley-driven fan appeared to fulfill the requirements of the purchaser; soon, however, the steam fan with direct-connected engine displayed its utility; but to-day the fan driven by an attached motor has shown its general superiority and is rapidly supplanting the steam fan. Progress along this line has been largely due to the energy and foresight of the B. F. Sturtevant Company, of Boston. For years past they have been perfecting designs and keeping abreast of the times in this important branch of engineering. . . . W. S. Hutton, in *Steam Boiler Construction,* states that 'the economy that may be obtained by combustion with forced draft in a steam boiler is due to the increased rate of combustion and increased efficiency of the heating surfaces produced by it resulting in increased boiler power. The increase of power obtained depends principally upon the quantity of air brought into intimate contact with the fuel in a given time, but the power of the boiler may generally be increased from 40 to 100 percent by the application of well-arranged forced draft,' such as is manufactured by the B. F. Sturtevant Company."

BUSINESS NOTES.

Highest honors for the Moncrieff gauge glasses.—The H. A. Rogers Company, 19 John street, New York city, reports that the Moncrieff Scotch gauge glasses, for which the company is the sole agent in the United States, were the only gauge glasses awarded a gold medal at the World's fair at St. Louis.

The Eureka Fire Hose Company in the South.—Mr. Warwick H. Payne, who has been connected with the Eureka Fire Hose Company, 13 Barclay street, New York city, for a number of years, has been placed in exclusive charge of the company's business in North and South Carolina and Virginia, with offices in the Century building, Atlanta, Ga.

Allen riveters for Mexico.—John F. Allen, 370 Gerard avenue, New York city, manufacturer of the Allen portable pneumatic riveting machine, who recently established an agency with A. H. Le Hand & Company, City of Mexico, has received an order from this firm for six riveters to be shipped to the Cia Consolidada de Construcciones Metalica, S. A., City of Mexico.

A satisfactory lubricant.—Adam Cook's Sons, makers of Albany grease, 313 West street, New York city, recently sent some samples of their grease to the Charleston Gas and Electric Company, Charleston, Ill. After testing same, E. C. Jenks, manager, wrote: "The samples shipped this company are all right, and we have ordered a supply from the George Henseler Oil Company, St. Louis, Mo."

Steel castings for engines.—Some steel castings received by W. D. Forbes Company, Hoboken, N. J., from the Providence Steel Casting Companv, Providence, R. I., have been machined for some special work where the closest inspection was necessary. These castings turned out to be perfect, and many cast-iron parts which W. D. Forbes Company is now using will hereafter be made of steel made by the Providence Steel Casting Company.

A popular variable speed-motor.—The Northern Electrical Manufacturing Company, Madison, Wis., reports that it has found extensive sale for its single-voltage, two-wire, variable speed-motors in all lines of industrial work. The field of the variable speed-motor is primarily the machine shop, as no other line of work calls for so many individual machines. However, Northern variable speed-motors are used in all kinds of industries for operating pumps, for boiler feed, circulation, etc, for ventilating and blowing fans, elevators, hoists, and conveyers. An extensive field for Northern variable speed-motors has been found in the cement industry, where variable speed drive is said to be especially advantageous.

An interesting yacht lighting exhibition.—The Richardson Engineering Company, Hartford, Conn., had on exhibition at the Motor-Boat Show, Madison Square Garden, New York city, a section of a yacht showing the interior of the cabin and engine room, with port lights, curtains, cushions, and pillows, all in position as they would be in a real yacht. There was in operation one of the company's No. 2-B electric light outfits, consisting of a generator belted to the engine, a storage battery in the locker, and switchboard in place connected to an arc searchlight, which was operated at intervals. The company's No. 2-B-5 switchboard was a complete yacht switchboard for the use of a storage battery large enough to operate arc searchlights at all times. It had a pilot-house, volt-meter, ammeter, volt-meter switch, regulating switch for the storage battery, rheostat, automatic circuit breaker, and tell-tales for indicating whether the side lights were burning or not. The exhibit also included a number of standard yacht and launch switchboards, and special electric fixtures as well as ignition storage batteries, besides a direct-connected set consisting of an imported De Dion motor direct-connected to a standard dynamo on an iron bed. This is very compact and is suitable for large launches, houseboats, sailboats, and like purposes where space is at a premium and lightness an advantage. There were also in operation a 9-inch lens mirror arc searchlight and a 12-inch incandescent searchlight.

AN EFFICIENT DOUBLE CHAMBER FURNACE.—Regarding its double chamber melting furnace, the Rockwell Engineering Company, manufacturer of rotary melting furnaces for copper, brass, bronze, aluminum, etc., 26 Cortlandt street, New York city, states that all the features of its furnace appeal to the practical foundryman, but none more so than its operation. With the possible exception of the lining more care was given to the operation than to any other feature. The first aim of the company was to produce a furnace that would melt rapidly, after this was accomplished every effort was put forth to make the furnace perform its work with every possible convenience and comfort for the operator. The operator likes the furnace because it melts rapidly and in large quantities, thus insuring economy and ease in operation.

MEDIUM-SIZED FAST PASSENGER STEAMERS.—The Marine Iron Works, Station A, Chicago, Ill., state that the new steamer they are now building for quick passenger service on northern Lake Michigan, represents a type of boat worth careful consideration by anyone interested in this subject. They refer to the best modern steam vessels, ranging from 75 to 160 feet in length. The one referred to has a finely modeled steel hull 142 feet long by 28 feet beam, and will draw with ordinary load 11 feet. Her triple-expansion machinery embodies all the practical features that long experience demonstrates is the best when actual worth rather than first cost is the prime consideration. The engine cylinder diameters will be 14 and 22 and 36 inches by 24 inches stroke fitted with steam reverse. These modern, quick-moving, medium-size dependable vessels on eight- to twelve-hour daily runs are far better producers than generally understood, and are gradually supplanting the old and slower-moving combination freight, tug, and passenger boats. Their first cost is necessarily greater, but generally the net results are in their favor before the close of even one season's business. The Marine Iron Works have also been awarded the contract for building the fore-and-aft compound condensing machinery for the new government survey boat for use on the Gulf of Mexico.

THE ALTEMUS TIMER AND SECONDARY DISTRIBUTOR.—C. L. Altemus & Company, The Bourse, Philadelphia, Pa., state regarding their timer and secondary distributor that its distinctive features are its simplicity, strength, and accuracy. But one coil is used, vibrating or non-vibrating, for any multiple cylinder engine, and since the entire system of battery, coil, connections, etc., finds expression in a single spark, explosions of maximum efficiency are produced with small battery consumption. The firm state that in nine cases out of ten the unsatisfactory behavior of a gas engine is due to the electrical wiring and connections, which grow more complicated as the number of cylinders increases. The employment of a coil for each cylinder means a complete circuit with all its accessories to produce a spark in any one cylinder. Multiply this by the number of cylinders your engine has, and the complication is apparent. To be successful in operation, a commutator of this character should be carefully and substantially constructed. It must be carefully laid out and put together so that the contacts are made at exactly the right time with regard to the position of the piston in the cylinder. It must be provided with long bearings, so that the proper alignment of the revolving parts and brushes will be maintained at all times, and it must be carefully insulated and made oil- and water-tight so that the chances for short circuiting will be reduced to a minimum. The Altemus device, so the firm states, fulfills all of the above conditions, and within the space of 3 inches by 2 3-4 inches.

THE NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS, with headquarters at 314 Madison avenue, New York city, was incorporated in May, 1904, by a number of the leading manufacturers of motors, boats, and accessories, who appreciated the growing need of co-operation and concerted action for the advancement of the industries which the association represents. The association has been very successful, and now includes among its members nearly all the leading motor and launch builders in the country. The objects of the association are the promotion and protection of the interests of its members; protection against unscrupulous agents, buyers, etc.; the protection of its members against unjust and adverse legislation; to avoid questionable advertising schemes, and to discuss improved methods of construction. The association was not organized for the purpose of increasing prices. In the matter of legislation, a very important matter to users of motor boats, the association will always be found safeguarding the interests of boat users. Through its bureau of information is distributed much information of general interest to manufacturers and operators of power boats, and in bringing about an annual national exhibition, it gives the public the opportunity of becoming acquainted with the various makes of motor boats, and to study and compare the leading makes of engines and hulls under one roof. The officers of the association are as follows: President, John J. Amory; first vice-president, H. A. Lozier, Jr.; second vice-president, Charles A. Strelinger; third vice-president, Henry R. Sutphen; treasurer, J. S. Bunting; secretary, Hugh S. Gambel.

A SUCCESSFUL ENGINE.—The International Power Vehicle Company, Stamford, Conn., has received the following letter from The Miller Plantation Company, 349 West 26th street, New York city: "The *Ina* and International kerosene engine is a great success. Anderson took her for a trip up to San Juan Evangelista, and is much pleased with her. When I went down to Tlacotalpam I made the distance of 80 miles in about eight hours. The Buena Vista Company has a launch on the river with a 24 horsepower triple-expansion gasoline engine which cost $4,000 gold. We overtook and passed her on the river as though she were standing still. They used $43.00 Mex. worth of gasoline between Tlacotalpam and here. We used $7.50 Mex. worth of kerosene, and did it in less than half the time. As the boat has been in almost constant service for nearly one year and has given perfect satisfaction, we take pleasure in reporting as above."

MANY ORDERS FOR SAILS.—Wilson & Silsby, Rowe's Wharf, Boston, Mass., have orders for suits of sails for the following yachts: 25-footer, Dr. Franklin Dexter; 25-footer *Babs*, E. B. Alford; 21-footer, R. E. Gregg; 18-footer *Broncho*, Charles Este; 30-footer *Ursula II*, Albert Stone; 21-footer, F. T. Catlin; 21-footer *Jack Rabbit*, W. H. Bradbury; 25-footer, A. C. Crawford, Nassau, Bahamas; 18-footer, Huntington Manufacturing Company; schooner *Agatha*, W. S. Eaton; iceboat, Archibald Rogers; 42-foot schooner, C. E. Gibson; 35-footer *Vayer II*, Dr. R. H. Hart, Philadelphia; eight suits for 15-footers, George Lawley; 35-foot yawl, Charles Longstreth, Philadelphia; 30-footer and 15-footer, Burgess & Packard; 21-footer *Tartan*, A. H. Pirie; 22-footer, Dr. E. W. Galvan; 22-footer, George Lawley; mainsails for R. H. Post, Porto Rico, and schooner *Hoosier*, Edgar Harding; No. 2 jib topsail for schooner *Chanticleer*, George W. Weld; spinnaker for Henry H. Palmer, San Diego, Cal., and set of awnings for steam yacht *Narada*, Vice-Commodore Henry Walters, New York Yacht Club.

MARINE ENGINEERING EMPLOYMENT BUREAU

Full information regarding the purposes of this Bureau, together with instructions regarding registration, etc., furnished upon application to MARINE ENGINEERING Employment Bureau, 17 Battery Place, New York city.

All correspondence, concerning either vacancies or situations wanted, is strictly confidential.

POSITIONS SEEKING MEN

DREDGE DESIGNER AND BUILDER wanted; one who has the necessary knowledge and experience to connect himself with a well-known dredge-building concern. File No. 47.

GAS ENGINE BUILDER wanted to combine his business with a boat building and repairing shop which has marine railways and an established business. File 40.

SUPERINTENDENT OF BOILER DEPARTMENT wanted in well known shipyard; must be capable of figuring costs in both repair work and new work; give full experience and references. File No. 45.

YACHT AND BOAT BUILDER wanted who understands inside joiner work and who is able to superintend the building of launches and yachts under all the branches. File No. 39.

MEN SEEKING POSITIONS

We have applications registered for positions as follows, and the references of each applicant have been carefully investigated:

BOILER-MAKER FOREMAN seeks position. Is at present foreman of railroad shops and has charge of nearly one hundred men; has had twelve years' experience as foreman; posted in the latest boiler practice; has best references as to ability and character; is 38 years old. Application No. 73.

BOILER-SHOP FOREMAN. Age 35; single; many years' experience in Navy Yard and leading shipyards. Application No. 59.

BOILER-SHOP FOREMAN. Age 37; single; 16 years' experience in boiler-shop work. Application No. 47.

CHIEF OR ASSISTANT CHIEF DRAFTSMAN—ENGINE. Age 33; married; has had sea experience and thirteen years as leading and chief draftsman of private and government shipyards. Application No. 25.

CHIEF DRAFTSMAN OR SUPERINTENDING ENGINEER seeks position. Has had extensive experience in several of the best known shipyards, and can furnish the best of references. Application No. 81.

CHIEF DRAFTSMAN OR CHECKER seeks position; is 36 years old; married; was with the Carnegie Steel Company for about three years; later with the National Steel Company, and with the American Bridge Company. Application No. 79.

DESIGNER AND DRAFTSMAN. Has had many years' experience in launch and river boat work. Designed some of the fastest river boats in the country. Application No. 61.

DRAFTSMAN, ENGINE AND BOILER. Age 30; unmarried; has Danish marine license; technical school graduate. Application No. 57.

DRAFTSMAN—HULL. Age 20; single; experienced in architectural work, but prefers marine drafting. Application No. 51.

DRAFTSMAN—HULL. Age 25; married; 9 years' experience in leading yards in drafting, testing materials, surveying, etc. Application No. 54.

DRAFTSMAN—HULL, OR INSPECTOR. Age 37; married; had experience both in government yards and private yards. Application No. 30.

DRAFTSMAN—HULL. Age 22; single; born in Norway; studied Technical schools in Norway and Germany; experience as draftsman, also as shipfitter. Application No. 31.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

12 West 31st Street, New York.

President, FRANCIS T. BOWLES.
Secretary-Treasurer, W. J. BAXTER.
Executive Committee, LEWIS NIXON, EDWIN A. STEVENS, HARRINGTON PUTNAM, STEVENSON TAYLOR. *Ex-officio*, FRANCIS T. BOWLES, W. J. BAXTER.

AMERICAN SOCIETY OF NAVAL ENGINEERS.

Navy Department, Washington, D. C.

President, Commander A. F. DIXON, U.S.N.
Secretary-Treasurer, Lieutenant CHARLES K. MALLORY, U.S.N. (retired.)
Council, Captain GEORGE W. BAIRD, U.S.N.; Commander J. K. BARTON, U.S.N.; Commander W. M. PARKS, U.S.N.

MARINE ENGINEERS' BENEFICIAL ASSOCIATION.

National President, FRANK A. JONES, 1959 Eddy St., San Francisco, Cal.
Vice-President, CHARLES W. ROBINSON, 908 G. St., N. W., Washington, D. C.
Second Vice-President, EVANS I. JENKINS, 153 Clinton St., Cleveland, Ohio.
Secretary, GEORGE A. GRUBB, 1318 Wolfram St., Lake View, Chicago.
Treasurer, ALBERT L. JONES, 289 Champlain St., Detroit, Mich.
Advisory Board, WILLIAM F. YATES, 120 Liberty St., New York city; GEORGE F. KEATING, 74 Webster St., East Boston, Mass.; W. D. BLAICHER, 10 Exchange St., Buffalo, N. Y.

ADDRESSES OF CORRESPONDING SECRETARIES.

No. 1, W. D. Blaicher, 10 Exchange St., Buffalo, N. Y.
" 2, Wm. Kelly, 11 Wall St., Cleveland, O.
" 3, A. L. Jones, 289 Champlain St., Detroit, Mich.
" 4, James A. Macauley, 5802 Indiana Ave., Chicago, Ill.
" 5, Otto Boettger, 1035 E. Hopkins Ave., Baltimore, Md.
" 6, Wm. Arste, 322 Pine St., St. Louis, Mo.
" 7, Wm. T. McElwee, Box 1556, Portland, Me.
" 9, Wm. Bridges, 784 1-2 12th St., Milwaukee, Wis.
" 13, John G. Paulding, 1746 Tulip St., Philadelphia, Pa.
" 14, Joseph F. Dumas, 403 Dauphin St., Mobile, Ala.
" 15, R. L. Skinner, 622 Louisa St., New Orleans, La.
" 17, Jas. D. Robinson, 6th and Columbia Sts., Newport, Ky.
" 18, Wm. Hurst, 715 Walnut St., Cairo, Ill.
" 20, Jos. B. Barry, 206 Keel St., Memphis, Tenn.
" 21, J. H. Foley, 206 N. Mulberry St., Vicksburg, Miss.
" 23, Wm. R. Lewis, 213 E. Front St., Jeffersonville, Ind.
" 24, Hugh L. Edwards, 511 Washington St., Paducah, Ky.
" 26, T. H. Kirkbridge, 228 Bond St., Evansville, Ind.
" 27, L. C. Schwall, 598 S. Madison St., Bay City, Mich.
" 29, James R. Sutherland, Charleston, W. Va.
" 30, E. R. Humphrey, 21 State St., Pittsburg, Pa.
" 33, James J. Waters, 283 Hudson St., New York, N. Y.
" 35, William M. Coombs, 36 East St., San Francisco, Cal.
" 36, Jos. Thomas, 57 Sea St., New Haven, Conn.
" 37, John B. Bender, 1215 Evesham Ave., Toledo, Ohio.
" 38, C. H. Wolford, 73 Starr Boyd Bldg., Seattle, Wash.
" 39, Frank Feeney, 460 E. 12th St., Erie, Pa.
" 40, Chas. Drouet, 1003 Ave. I, Galveston, Tex.
" 41, W. H. Marshall, 343 Holladay St., Portland, Ore.
" 42, Jas. Manning, 802 E. Duval St., Jacksonville, Fla.
" 43, A. J. Wilson, 1327 La Peer Ave., Port Huron, Mich.
" 44, Chas. J. Sullivan, 480 1st St., Manistee, Mich.
" 45, W. L. Salter, care O. S. S. Co., Savannah, Ga.
" 46, D. W. Farrell, Clayton, N. Y.
" 47, J. R. Cook, Sault Ste. Marie, Mich.
" 48, Alfred Hegemer, 140 E. Park St., Sandusky, O.
" 51, H. S. Connell, 12 Ranson St., Muskegon, Mich.
" 53, Harry Stone, Box 445, Marine City, Mich.
" 55, Archie Stalker, Box 883, Cheboygan, Mich.
" 57, E. B. Meeker, 71 Abeel St., Kingston, N. Y.
" 58, E. Capers Haselden, Box 31, Georgetown, S. C.
" 59, George F. Keating, 74 Webster St., E. Boston, Mass.
" 62, N. S. Lawrence, 30 Connecticut Ave., New London, Conn.
" 63, M. J. Burke, 152 Sheridan Ave., Albany, N. Y.
" 65, W. C. Palmer, care Consumers' Coal Co., Charleston, S. C.
" 67, James K. Dole, Saugatuck, Mich.
" 70, Charles T. Smith, 665 Commercial St., Astoria, Ore.
" 72, Wm. T. Findlay, 130 W. Bridge St., Oswego, N. Y.
" 73, E. M. Donahue, 1308 Cherry St., Green Bay, Wis.
" 75, Wm. D. Hemenway, Alexandria Bay, N. Y.
" 76, Orson Vanderhoef, Grand Haven, Mich.
" 77, John P. Hall, 1215 Huron St., Manitowac, Wis.
" 78, J. P. Burg, 2722 Minnesota Ave., Duluth, Minn.
" 80, Edward S. Welch, 338 Hamilton St., Albany, N. Y.
" 81, Jas. L. Sweeney, 206 E. Sarragosa St., Pensacola, Fla.
" 82, Fred H. Gowell, 427 Middle St., Bath, Me.
" 85, John A. Packard, 623 Merchant St., Alpena, Mich.
" 86, Sherman A. Smith, 737 Menekaunee Ave., Marinetta, Wis.
" 87, George B. Milne, 809 Fourth St., Detroit, Mich.
" 88, C. O. Chapman, S. B. Canal, Sturgeon Bay, Wis.
" 89, Geo. E. Willard, 4 Isabella St., Ogdensburg, N. Y.
" 91, A. L. McLaren, 130 W. Walnut St., Ashtabula, O.
" 92, Jos. D. Budd, Box 50, Sta. I, Saginaw, W. S., Mich.
" 93, W. J. Cook, 2220 G. St., N. W., Washington, D. C.
" 94, George R. Jones, Box 222, Washington, N. C.
" 95, P. J. McMahon, Box 199, Key West, Fla.
" 98, C. N. Vosburg, 6323 Patton St., New Orleans, La.
" 100, H. F. Mocine, Honolulu, H. I.
" 101, J. K. Cotton, Box 765, Norfolk, Va.
" 102, Fred. W. Linsemeyer, 210 Clinton St., South Haven, Mich.
" 103, A. E. Pittman, Box 378, New Bern, N. C.

TRADE PUBLICATIONS.

The Brennan standard motor, for launches and automobiles, is described and illustrated in a catalogue issued by the Brennan Motor Company, Syracuse, N. Y.

Elevators, towers, over-head trolleys, conveyors, coal-crackers, cable railways, industrial railways, blocks, ropes, etc., are described in Pamphlet No. 052 issued by C. W. Hunt Company, West New Brighton, Staten Island, N. Y.

"Economical Gas and Oil Engines" is the title of a folder sent out by the De La Vergne Machine Company, foot of East 138th street, New York city. The company will send free upon application a description of its portable and fixed engines with pumps, dynamos, or air compressors.

Lathe chucks.—A catalogue of Westcott's patent lathe chucks and "Little Giant" drill chucks, manufactured by the Westcott Chuck Company, Oneida, N. Y., has been received. The "Little Giant" drill chucks have no projections. The jaws and screws are all within the body of the tool.

The bending book issued by Estep & Dolan, Sandwich, Ill., explains how any shop doing much bending work can save money. The eye-hand bending machine is claimed to do this. Other machines built by this company are sheet-metal shears and angle benders operated by hand.

"The Economy of Clean Boilers, a practical method of dealing with the expenses due to the neglect of boilers," is the subject of a pamphlet issued by the Greacen-Derby Engineering Company, Perth Amboy, N. J. The pamphlet states that the secret of success in steam boilers is clean water, and goes on to describe and illustrate the Blackburn Smith feed-water filter and grease extractor.

Thor pneumatic tools and appliances are described in a folder issued by the Aurora Automatic Machinery Company, Aurora, Ill. The Thor air-drills are fitted with reciprocating piston, Corliss-style valves, and telescopic feed. Various air-drills are shown, and also pneumatic hammers. These drills and hammers are claimed to develop the maximum power for a given consumption of air.

A new sketching paper for making drawings and sketches in isometric perspective, is for sale by the Derry-Collard Company, 256 Broadway, New York city. A circular issued by the company states "any special knowledge of isometric projection is now unnecessary, inasmuch as Dr. Robert Grimshaw has devised a ruled paper on which isometric drawings may be made without fuss or calculation."

Steam turbine motors, dynamos, blowers, centrifugal pumps, marine generating sets, etc., are described in illustrated Catalogue B, issued by the De Laval Steam Turbine Company, Trenton, N. J. This company is the sole manufacturer in the United States, Mexico, and Central and South America of the De Laval patents. Besides this catalogue the company issues a number of booklets which will be forwarded upon application. Among them are catalogues describing "Steam Turbines and Turbine Machinery," "Test of 300 H. P. Turbine Dynamo," "Steam Turbine Dynamos," "Steam Turbine Motors," "Steam Turbine Centrifugal Pumps," and "Works and Product of the De Laval Steam Turbine Company."

Boiler shop, rolling mill, steel works, tube mill, and bridge-works' machinery and equipments are described in a 172-page catalogue issued by the Fischer Foundry and Machine Company, Pittsburg, Pa. This is a handsome catalogue containing nearly two hundred illustrations, yet the company states that it illustrates only a limited number of the machines it builds. In most cases only one machine of each type is shown. In addition to the line of machinery illustrated in the catalogue, the company is prepared to build special machinery for any purpose. The company will furnish upon application illustrations or drawings and other data of machinery included in the classes shown in the catalogue but not therein listed.

Portable tools for repair shops are illustrated and described in a 36-page catalogue issued by H. B. Underwood & Company, 1025 Hamilton avenue, Philadelphia, Pa. Regarding the company's portable boring bar, the catalogue states that it is made in several sizes and is designed for general boring. All kinds of engines, steam hammers, pumps, blowing engines, air compressors, Corliss valves, etc., can be bored in place. It has fixtures for boring—with one or both cylinder heads off—in any position and in cramped places, as on board ship. It can be operated in any space that is large enough to take the piston out of the cylinder. Cylinders may be rebored in place in less time than they could be removed from fixed position, leaving steam connections, holding-down bolts, etc., intact. The bars are powerfully geared and may be driven by power or by hand.

Pnuematic hammers are the subject of an illustrated mailing card sent out by the Ingersoll-Sergeant Drill Company, 26 Cortlandt street, New York city.

Vertical milling machines are described and illustrated in Catalogue No. 40 issued by the Newton Machine Tool Works, Philadelphia, Pa.

Lathe chucks and "Little Giant" drill chucks are described and illustrated in Catalogue A, issued by the Westcott Chuck Company, Oneida, N. Y.

The nautical almanac for 1905, issued by Riggs & Brother, 310 Market street, Philadelphia, Pa., will be found valuable to mariners, and will be forwarded by the company postpaid upon receipt of ten cents.

"Reduction of Load on Steam Engines," is the title of an article by W. H. Wakeman, which is running in *Graphite*, published by the Joseph Dixon Crucible Company, Jersey City, N. J. Free copies will be sent upon application.

"Vortex" centrifugal pumps are illustrated and described in a booklet issued by the Lawrence Pump and Engine Company, Lawrence, Mass. The booklet states that these pumps are suitable for pumping out dry-docks and for wrecking and dredging purposes, and that they may be used in any place where water is to be elevated to a moderate height quickly and cheaply.

The Thompson damper and pressure regulator is the subject of a catalogue issued by Richard Thompson & Company, 126 Liberty street, New York city. The catalogue states that this regulator will open or close the damper on a variation of one pound of steam, or will make a partial stroke in either direction, and stand at any intermediate point between the open and closed positions.

Forgings and castings, armor plate and ordnance material, and bar-steel of every description, are described and illustrated in a catalogue issued by the Midvale Steel Company, Philadelphia, Pa. The catalogue states this company furnished all the engine-forgings and shaftings in the following ships: U. S. battleship *Nebraska;* the *Sierra, Sonoma,* and *Ventura,* owned by the Oceanic Steamship Company; the *Siberia* and *Korea,* belonging to the Pacific Mail Steamship Company; and the Great Northern Steamship Company's *Minnesota* and *Dakota.*

Flexible steel-armored hose. for steam or compressed air, is described and illustrated in Bulletin No. 505, issued by the Sprague Electric Company, 527 West 34th street, New York city. The bulletin states that the company's flexible steel-armored hose consists of a rubber hose covered with a tight-fitting flexible steel armor, thus protecting the rubber against injury. The strength of the hose is greatly increased because the steel armor binds the rubber hose, preventing it from expanding. A three-ply hose thus armored, the bulletin states, will stand a hydraulic pressure of 2,000 pounds.

"The Dixon Belt Dressing" is the title of a booklet issued by the Joseph Dixon Crucible Company, Jersey City, N. J., which deals with the subject of the care and renewal of belts—the causes of their slipping from overloading, clogging up, glazing, or drying out. The question of slack belts and overtight belts is also dealt with. The work concludes with an investigation of the belt dressings now employed, vegetable and animal oils, resin, waterproof dressing, etc. The advantages of Dixon's belt dressing are pointed out, and directions given for its application. A free copy of the book may be had upon application.

Welding of broken bosses on rolls.—The Goldschmidt Thermit Company, 43 Exchange Place, New York city, has issued a pamphlet describing the welding of broken bosses on rolls by means of thermit. The advantage of their process, the company states, lies in the fact that thermit can be ignited on the piece direct, the expense of a crucible being obviated. This operation takes about thirty pounds of thermit to the square foot, and a steel boss can be welded on a cast-iron roll, as well as a cast-iron boss, and *vice versa.* The testimonials in the pamphlet indicate some of the works which have used this process, which is said to be in general use in Europe.

The Navigator's or Mariner's Guide.—The second edition of *The Navigator's or Mariner's Guide* will be issued in a few days. It is published by Mr. Harry Louderbough, proprietor of the New Jersey Paint Works, Jersey City, N. J., and will be mailed to those interested on receipt of 25c. in stamps or silver to defray cost of mailing. The work has been enlarged and revised by Captain R. M. Pugsley, and contains a great amount of practical matter regarding navigation, seamanship, etc.; also many fine illustrations, some of which show the method of reading the various nautical instruments. The drawings and the work in general are of great value to navigators. Capt. Pugsley has contracted with the New England Company, Bath, Me., for the building of a barkentine which he will command.

"Compressed Facts About Compressed Air" is the title of a booklet issued by the Clayton Air Compressor Works, 114 Liberty street, New York city, giving "a resumé of the points to be considered in buying an air compressor of medium capacity."

The marine gasoline engines built by the Rochester Gas Engine Company, Rochester, N. Y., are described in an illustrated catalogue this company is distributing. The catalogue states: "It is our desire to manufacture an engine that is simple to operate and at the same time efficient in its operation. Any gas engine can be readily understood and is very simple to the man who is thoroughly acquainted with gas engines in general, but to the man who is a novice, it is quite another proposition, and as the great majority, especially the smaller sizes of these engines, are operated by those whose knowledge of gas engines is limited, we are of the opinion that the simpler the engine and the easier it is understood the more efficient and reliable it will be at all times. Owing to the construction of some types of engines, it is necessary to have many intricate moving parts which constantly require adjustment and attention, and we have known cases where engines have had to be returned to the manufacturer for the reason that the owner could not be given sufficient instruction at long range to properly adjust parts that had become deranged. To avoid the above and other difficulties, which continually arise, we are building an engine of the *three port type,* which is the acme of simplicity and perfection, not having a single moving valve or spring in its make-up, and this feature alone, when compared with the many parts necessary for the operation of valves, ignition apparatus, etc., immediately recommends itself to the purchaser, who is in search of a gas engine whose troubles are few and which will operate economically and successfully."

"Our specialty is speed wheels," is the statement made by the Michigan Motor Company, Grand Rapids, Mich., in an illustrated circular it is sending out. It is further stated that "one hand controls them perfectly. All wheels are made of special propeller wheel bronze, which is non-breakable."

Pennsylvania metallic packing is described in a folder issued by the Pennsylvania Metallic Packing Company, 209 Robinson street, Allegheny, Pa. The folder states that this packing is composed of a combination of the finest bearing metal obtainable and a well-known lubricant. Thin strips of babbitt metal coated with Dixon's flaked graphite are wound into moulds and pressed to the ring form required to suit the conditions of the stuffing-box. These complete rings are then parted into segments. It is claimed for this packing that it is unaffected by the action of acid, alkali, oil, or sulphurous water; that it will not cut or score rods or plungers; that it does not attract, nor will it retain, grit; that it is self-lubricating; that it reduces friction to a minimum, and that it will pack for any service in which the temperature is below 450 degrees.

Marine gasoline engines are described and illustrated in a catalogue issued by the Eagle Bicycle Manufacturing Company, Torrington, Conn. The catalogue states: "We take pride in the finish of our engines. Where a piece of machinery is subjected to exposure, durability of finish is of the utmost importance. The finish applied to the cylinder and crank-base of our engine is a durable and brilliant black enamel. This makes a fine finish, impervious to heat or grease. All nickel plating is done over a heavy coating of copper. We produce an engine with all parts so mechanically perfect as to be interchangeable. New parts may be ordered and fitted to the engine without annoyance or delay. The main bearings, or crank-boxes, are of phosphor bronze accurately machined. The main connecting rod and the eccentric connecting rod are of the same material. The crank-shaft is drop forged of a high quality steel. The cylinder head, as well as the side walls of the cylinder, is surrounded by a water-jacket, keeping the entire top of the engine cool to the touch. In our 1905 sparking device we have embodied some new mechanical features. We use the make-and-break contact system with an improved method for bringing the contact points together under compression. This being a vital part, we have spared no expense in designing a sparking device which would be easily understood, neat in appearance and of the finest workmanship. The sparking mechanism is placed on the front of the engine. Both the firing pin and movable electrode are contained in one plate which make them easy of access, so they can readily be detached. With our new devices we can instantaneously regulate the speed of our engine to almost any given number of revolutions per minute and the engine will run steadily at these various speeds without missing explosions. This perfect speed control is obtained without in any way interfering with the vaporizer, which, when once adjusted to form a perfect mixture, need not be changed. The speed is controlled by new and simple devices, giving an instantaneous and wide range in time of spark ignition, with relation to the position of the piston; and in connection therewith we use a throttle-valve by which the amount of gas mixture admitted into the explosion chamber can be regulated to a nicety. Safety in a boat demands that the speed should be subject to quick control. Many gas engines cannot be slowed down except by weakening the mixture of gas and air at the vaporizer. The main bearings of our engine are self-oiling. The bronze bearing sleeves are slotted and a felt wick adapted for the purpose is inserted, which absorbs and transmits the oil directly to the surface of the shaft."

Pipe-fitters' tools.—The "Blue Catalogue" of pipe-fitters' tools, showing the complete line issued by the Walworth Manufacturing Company, 128 Federal street, Boston, Mass., will be sent free upon application.

The Blue Book of American Shipping for 1905 has been issued by the Penton Publishing Company, Cleveland, Ohio. This is a volume of 500 pages, and according to a circular contains "complete and authentic data and statistics covering every phase of America's marine and shipping interests."

Yacht designs free.—A handsomely printed book containing about forty selected designs of yachts, from 100 feet in length down to launches 18 feet long, will be sent free to any reader of Marine Engineering by the Michigan Motor Company, Grand Rapids, Mich., on condition that twenty-five names of boat owners, or possible boat owners, are sent the company with the request for the book. The price of the book if sold separately is $1.

Seamless drawn brass and copper tubes, etc.—The 1905 catalogue issued by the Waterbury Brass Company, Waterbury, Conn., contains tables and weights of seamless drawn brass and copper tubes, brazed tubes, brass and copper in rod, wire, and sheets; also tables which are short cuts in arriving at certain results in figuring outside and inside diameters of seamless tubes for the weights, and also in connection with rod, wire, and sheet brass and copper. The catalogue contains a complete list of the stock carried in the company's Waterbury and Providence warehouses.

Air compressors.—The Rand Drill Company, 128 Broadway, New York city, has issued two air compressor catalogues, Nos. 10 and 11. No. 10 describes the "Imperial" Type 10 steam, belt, gear, and silent chain-driven air compressors, giving speed capacities, air pressures, horsepowers, etc., and is illustrated with half-tone cuts. Catalogue No. 11 illustrates and describes "Imperial" Type 11 machines, which are vertical compressors built for driving by belt, gear, and silent chain.

"Flange Joint Gaskets" is the title of an illustrated pamphlet issued by the H. W. Johns-Manville Company, 100 William street, New York city. This pamphlet states: "To successfully pack a flange joint, a gasket is required that will withstand the highest temperature and pressure; will be sufficiently elastic to compensate for the expansion and contraction; in itself is not subject to expansion or contraction due to changes in temperature; will maintain a perfectly tight joint against the vibration of the line; will prevent leakage of steam or condensation. "Kearsarge" flange joint gaskets meet every one of the foregoing requisites for an efficient, durable gasket, and are constantly overcoming difficulties where all others have failed. Since we placed them on the market a year ago their sale has grown very rapidly. Many of the largest steam fitters in the country have adopted them as standard, and we have had no unsatisfactory reports from their use where properly applied."

The marine gasoline motors built by the Lamb Boat and Engine Company, Clinton, Ia., are concisely described and handsomely illustrated in Motor Catalogue D, a free copy of which will be forwarded upon request. The catalogue states: "In presenting our 1905 catalogue we wish first to call attention to three of the factors that have been largely instrumental in our success. These are: progress in design and development; high quality of construction and appearance; and fair dealing with our customers. We are building two types of marine motors, the two-cycle type, in sizes from 1 1-2 to 10 horsepower, and especially recommend this type for small pleasure launches. The Lamb four-cycle motors are built in sizes from 10 to 60 horsepower, in two, three, and four cylinders. We frequently find the wish expressed for fuller information in regard to the principles of action, cost of operation, and stability of two- and four-cycle motors. We have tried in this catalogue to avoid going into a lengthy discussion, and at the same time to make all the essential points clear. If we have failed in the latter, we shall be pleased to take up the point with you by correspondence."

CATALOGUES AND CIRCULARS FREE.

Catalogues and circulars were distributed at the recent Motor Boat and Sportsmen's Show, held in Madison Square Garden, New York city, by the following concerns, and free copies of them may be obtained by writing to the companies at the addresses given, and mentioning Marine Engineering.

Marine oil engines.—A. Mietz, 128 Mott street, New York city.

Lacy marine gasoline engines.—The Brown-Cochran Company, Lorain, Ohio.

Victor non-corrosive silver.—The Victor Metals Company, East Braintree, Mass.

Walrath gas engines.—The Marinette Gas Engine Company, Chicago Heights, Ill.

Self-clearing propellers.—The Norwalk Brass Company, Norwalk, Conn.

Marine gasoline engines and launches.—Palmer Brothers, Cos Cob, Conn.

The Shaw propeller.—The Shaw Propulsion Company, 52 Broadway, New York city.

Marine gasoline engines.—The Clifton Motor Works, 234 East Clifton avenue, Cincinnati, Ohio.

White gasoline engines.—The Globe Iron Works, Menomonie, Wis.

Kerosene engines.—The International Power Vehicle Company, Stamford, Conn.

Rice marine engines and launches.—John V. Rice, Jr., & Co., Bordentown, N. J.

"Western" marine engines and launches.—The Western Launch and Engine Works, Michigan City, Ind.

Gasoline marine engines.—The Buffalo Gasolene Engine Company, 1280 Niagara street, Buffalo, N. Y.

Standard dry cells and auto gas.—William Roche, 52 Park Place, New York city.

Marine gasoline engines.—Smith & Mabley, Inc., New York city.

Engineering specialties.—The Lunkenheimer Company, Cincinnati, Ohio.

Marine gasoline engines.—The Spaulding Gas Engine Works, St. Joseph, Mich.

Marine motors.—Louvet & Son, Woodhaven, N. J.

Electric light outfits and searchlights for yachts and launches. The Richardson Engineering Company, Hartford, Conn.

Magnetic liquid indicators for gas-engine tanks. The R. & C. Indicator Company, Bridgeport, Conn.

Edison primary batteries.—The Edison Manufacturing Company, Union Square, New York city.

Marine motors.—The Trebert Auto and Marine Motor Company, Rochester, N. Y.

Snecker gasoline engines and launches.—The Stamford Motor Company, Stamford, Conn.

Double tube injectors.—The Schutte & Koerting Company, 12th and Thompson streets, Philadelphia, Pa.

Marine gasoline engines, auto boats, yachts and launches.—The Standard Motor Construction Company, 172 Whiton Street, Jersey City, N. J.

Marine gasoline engines.—James Craig, 556 West 34th street, New York city.

Gas engines.—Warren H. Jeffers, 373 Canal street, New York city.

Forstner bits for wood-working.—The Progressive Manufacturing Company, Torrington, Conn.

Marine steam and gasoline engines, launches, yachts, and working boats. The Lamb Boat and Engine Company, Clinton, Iowa.

Marine gasoline engines and launches.—The Lozier Motor Company, 1 Broadway, New York city.

Marine gasoline engines and launches.—The Truscott Boat Manufacturing Company, St. Joseph, Mich.

Launches, yachts, and auto boats.—The Williams-Whittelsey Company, Long Island City, N. Y.

Marine gasoline engines.—The Mianus Motor Works, Mianus, Conn.

Marine gasoline engines.—The Hubbard Motor Company, Middletown, Conn.

Swasey, Raymond & Page, naval architects, Colonial Building, Boston, Mass., circulars showing designs of launches designed and for sale by them.

Magnetos for touch and jump-spark ignition.—The Remy Electric Company, Anderson, Ind.

Marine hardware.—C. D. Durkee & Co., 2 South street, New York city.

Marine reverse gears.—The Carlyle Johnson Machine Company, 356 Asylum street, Hartford, Conn.

Marine gasoline motors.—E. H. Godshalk & Co., 23d street and Hamilton avenue, Philadelphia, Pa.

Gasoline engines and launches.—The Lozier Motor Company, 1 Broadway, New York city.

Gasoline and naphtha launches and engines.—The Gas Engine and Power Company, and Charles L. Seabury & Co., Consolidated, Morris Heights, N. Y.

Electric and gasoline engines and launches.—The Electric Launch Company, Bayonne, N. J.

Marine gasoline engines and launches.—Panhard & Lavassor Auto Company, 230 West 13th street, New York city.

Marine and automobile engines.—The Grant-Ferris Company, Troy, N. Y.

Gasoline engines, launches, and row and sail boats.—The Fairbanks-Grant Manufacturing Company, Ithaca, N. Y.

Hydro-carbon motors for launches and automobiles.—The G. A. Bachmann Motor Company, Baltimore, Md.

Gas and gasoline engines.—Newark Gas Engine Company, Newark, N. J.

"Perfection" reversing gear.—William H. Brodie Company, 45 Vesey street, New York city.

BUSINESS NOTES.

ANCHORS FOR THE PEARY SHIP.—The Baldt Anchor Company, Chester, Pa., has received an order to supply the anchors for the ship which McKay & Dix, 6 Battery Place, New York city, are building for Commander Peary for his next Arctic exploration.

"KEARSARGE" GASKET TUBING is a recent addition to the list of "Kearsarge" packings manufactured by the H. W. Johns-Manville Company, 100 William street, New York city. This company also makes "Kearsarge" ring packing, a new form of its coil packing. Samples will be sent upon application.

AN HYDRAULIC ASH EJECTOR.—The Marine Manufacturing and Supply Company, 157 South Street, New York City, says, regarding Thorne's patent hydraulic ash ejector: "This ejector will eject more ashes with less water than any other ash ejector made. It will not clog. The auxiliary jet prevents this. The small hand wheel operates a valve which diverts a stream of water from the main jet and conducts it through a passage in the wall of the hopper, where it is deflected downward and around the side of the same. This effectually clears the hopper, and, furthermore, by filling the discharge opening with water and spray, it assists the vacuum or draft of the main jet."

Mr. Matthew Carey, upon the recent completion of twenty-five years in the employment of the H. A. Rogers Company, dealers in machinists' supplies, 19 John street, New York city, was presented with a handsome testimonial by the company as a token of appreciation of his services.

Cleveland pneumatic tools.—The Circuit Court of Appeals, Philadelphia, Pa., in an appeal brought by the Cleveland Pneumatic Tool Company, Cleveland, Ohio, against a decision rendered in favor of a rival company which had secured a verdict against the Cleveland company in a suit regarding pneumatic tool-handles, rendered a decision on March 6 in favor of the appellants, the effect of the decision being to entirely exonerate the Cleveland Pneumatic Tool Company from any infringement.

"Gladiator" high-pressure ring-packing, says the New Jersey Asbestos Company, Camden, N. J., is now being used by hundreds of engineers who never before could afford the luxury and convenience of packing in this form. This "Gladiator" packing is molded in steel dies under hydraulic pressure. The rings are very durable, and, being made of asbestos, will not burn or char, and, being molded to shape, they are accurate in size, clasping the rod snugly all around, thus often saving burned fingers and other troubles. The New Jersey Asbestos Company also makes many other asbestos specialties, such as asbesto-metallic sheeting, asbesto-metallic tape, asbestos mill-board, asbesto-metallic gaskets, asbesto-magnesia sectional steam-pipe covering, etc. Catalogue sent free upon request.

Allen riveting machines.—John F. Allen, 370-372 Gerard avenue, New York city, manufacturer of the Allen riveting machine, is in receipt of a letter from his Glasgow, Scotland, agents, John Turnbull, Jr., & Sons, which tells of an interesting demonstration of the Allen machines in Glasgow, as follows: "With regard to the 84-inch boiler riveter, we have been demonstrating it in a shipyard, and the work done, which was on two boiler plates, was perfectly satisfactory. The plates were closed in good style. Our clients have secured a government contract in Malta, and they are anxious to use the riveters on the caissons which they will build there. With this in view we advertised extensively that a demonstration was to be made and we invited by letter most of the shipbuilders and boilermakers in and around this city. We also managed to secure the presence of a government inspector. The machine was put to work on a line of rivets, after which the plate was sawed in two, and the government inspector was perfectly satisfied with the manner in which the machine had driven the rivets and the way the plates were closed."

W. T. Bonner & Co., 53 State street, Boston, Mass., manufacturers of engineering specialties, have incorporated under the name of The Wm. T. Bonner Company. Large quarters have been secured at 244-248 Summer street, Boston, where the general offices and the selling and manufacturing departments will be united. The new company states that the scope of its business will be extended to cover a larger line of steam-plant accessories than formerly, and that especial attention will be given to the manufacture of specialties for high-pressure and superheated steam. A full line of cushion pressure-seated control cocks, blow-off, and other valves of a new type designed by Mr. Bonner, will be manufactured in all sizes up to 4 inches. Among the other specialties the new company will manufacture are "Wiltbonco" gauge mountings, quick opening; "Reflex" water gauges; "Wiltbonco" cushion pressure-seated control cocks; "Freeport" blow-off valves, interchangeable, renewable, no pockets for sediment; "Wiltbonco-Hogan" waste-oil filters; "Wiltbonco-Cooperite" sheet packing; "Safety" plastic metallic packing; "Wiltbonco-Monarch" gauge glass protectors; "Wiltbonco-Grief" gauge-glass tubes.

Electric hoist controllers and limit switches.—The Sprague Electric Company, 527 West 34th Street, New York City, says regarding its electric hoist controllers: "The life of an electric hoist is to a large extent dependent on the reliability of the controller and limit switch furnished. A controller or limit switch that is unreliable, not only causes shut-downs of the hoist, due to failure to operate, but it is also liable to burn out the motor or to injure the hoist proper and destroy life or property. This injury of the hoist, due to defects in the controller or limit switch, may be caused by inability to shut off the current, thus causing the ropes to wind or unwind beyond the proper hoisting limits, and so cause the hook block to strike the hoist with great force, injuring the frame, stripping the gears and possibly dropping the load. There is only one style of controller that is durable, reliable and safe, the cylinder-type controller, now used on all electric railways, electric locomotives and on nearly all electrical apparatus used to transport passengers and freight. The durability and safety of the cylinder controller is so universally recognized that no argument is needed to establish these points. All Sprague electric hoists are equipped with limit switches and cylinder controllers."

Closing bulkhead doors by electricity.—The new United armored cruiser *Colorado* has been equipped with a full set of safety electric water-tight power doors and hatch-gears, manufactured by the "Long Arm" System Company, Cleveland, Ohio. The *Colorado* is said to be the first vessel in any navy to be furnished with such equipment.

The course in naval architecture at the Grand Rapids School of Mechanical Drawing, Grand Rapids, Mich., has been prepared by men who have spent many years in the study of boat-designing, from the smallest pleasure launches up to designing of large sailing vessels. The course consists of elementary drawing, including geometrical drawing, advanced mechanical drawing, the building of a model for the hull of the boat; instructions and the necessary drawings being given to enable the student to begin from the building of the model to the completed design and a working drawing of the same, complete in every detail, from a small 20-foot launch, leading up to the complete design of finished launch with cabin. It is claimed that these drawings are very accurate, and that any person understanding them can readily follow the student's work, if he has carefully followed instructions. It is necessary in order to take this course that a student be fully familiar with mechanical drawing before starting the boat designing. He, therefore, is required to take a complete course in mechanical drawing before beginning his work on naval architecture. The two combined in one course, the price of which is less in many cases than the price of a single blue print for a small launch is therefore an opportunity that anyone desiring to learn the art of boat building cannot afford to miss. Should the student already have had experience in mechanical drawing, upon a written request from him giving samples of his work, he may take the naval architecture course without reviewing the general course in mechanical drawing, special discount being given to students who take the complete course. Many students are said to be earning their course by securing students for the school that are interested in mechanical drawing, liberal commissions being given for each student that he secures. In order to receive this commission a student must first obtain the number of students to pay his first installment, or be an enrolled member of the school.

MARINE ENGINEERING
EMPLOYMENT BUREAU

Full information regarding the purposes of this Bureau, together with instructions regarding registration, etc., furnished upon application to Marine Engineering Employment Bureau, 17 Battery Place, New York city.

All correspondence, concerning either vacancies or situations wanted, is strictly confidential.

POSITIONS SEEKING MEN

GAS ENGINE BUILDER wanted to combine his business with a boat building and repairing shop which has marine railways and an established business. File 40.

MEN SEEKING POSITIONS

We have applications registered for positions as follows, and the references of each applicant have been carefully investigated:

ASSISTANT OR SUPERINTENDING ENGINEER to shipping concern or factory seeks position; is 30 years old, married, and has had several years experience at sea as chief engineer. Application No. 100.

BOILER-MAKER FOREMAN seeks position. Is at present foreman of railroad shops and has charge of nearly one hundred men; has had twelve years' experience as foreman; posted in the latest boiler practice; has best references as to ability and character; is 38 years old. Application No. 73.

BOILER-SHOP FOREMAN. Age 35; single; many years' experience in Navy Yard and leading shipyards. Application No. 59.

BOILER-SHOP FOREMAN. Age 37; single; 16 years' experience in boiler-shop work. Application No. 47.

CHIEF OR ASSISTANT CHIEF DRAFTSMAN—ENGINE. Age 33; married; has had sea experience and thirteen years as leading and chief draftsman of private and government shipyards. Application No. 25.

CHIEF DRAFTSMAN OR SUPERINTENDING ENGINEER seeks position. Has had extensive experience in several of the best known shipyards, and can furnish the best of references. Application No. 81.

CHIEF DRAFTSMAN OR CHECKER seeks position; is 36 years old; married; was with the Carnegie Steel Company for about three years; later with the National Steel Company, and with the American Bridge Company. Application No. 79.

DESIGNER, EXPERIENCED, of dredges and other types of vessels, seeks position; is 28 years old; has had 10 years of experience in Great Britain and this country in leading shipyards. Application No. 82.

DESIGNER AND DRAFTSMAN. Has had many years' experience in launch and river boat work. Designed some of the fastest river boats in the country. Application No. 61.

DRAFTSMAN, ENGINE AND BOILER. Age 30; unmarried; has Danish marine license; technical school graduate. Application No. 57.

DRAFTSMAN—HULL. Age 20; single; experienced in architectural work, but prefers marine drafting. Application No. 51.

DRAFTSMAN—HULL, OR INSPECTOR. Age 37; married; had experience both in government yards and private yards. Application No. 30.

DRAFTSMAN—HULL. Age 22; single; born in Norway; studied Technical schools in Norway and Germany; experience as draftsman, also as shipfitter. Application No. 31.

DRAFTSMAN—HULL. Age 27; single; has had six years' experience on government work and in private yards; graduate of Webb's Academy. Application No. 65.

DRAFTSMAN—HULL AND ENGINE. Age 26; single; graduated Webb Academy; has had four years' experience in navy yard work; desires connection with private shipyard. Application No. 41.

DRAFTSMAN—ENGINE, STEAM OR GAS. Forty-three years old; single; born in Germany; has had extensive experience in designing and drafting; has had sea experience. Application No. 32.

DRAFTSMAN—MARINE. Age 34; married; accustomed to intricate drafting work. Application No. 50.

DREDGE DESIGNER seeks position; has had 10 years' experience in designing and building dredges of all kinds. Application No. 99.

DREDGE OR SHIPBUILDER who has had 20 years of experience in calculating and designing in connection with dredges and other vessels seeks position. Application No. 83.

ENGINE SUPERINTENDENT OR DESIGNER. Age 45; married; many years' practical experience in well-known shipyards with engines, auxiliaries, etc. Application No. 56.

GANG FOREMAN IN ERECTING SHOP OR FITTING UP ENGINES IN SHIPS. Age 37; married; has been with present employers 15 years. Application No. 26.

GAS ENGINE DRAFTSMAN seeks position; is 27 years old; married; technical-school graduate; has had several years' sea experience, as well as a number of years of special work in connection with gas engines; has had experience in building these engines up to 1,500 horsepower; thoroughly posted on all office detail and laying out work. Application No. 97.

GAS ENGINE OPERATOR. Age 28; single; born in Germany; 7 years' experience; understands gas engines thoroughly. Application No. 48.

HULL SUPERINTENDENT. Age 42; married; born and learned trade in Scotland, studied at Glasgow School of Naval Architecture, experienced as foreman; surveyor and hull superintendent. Application No. 27.

LAUNCH AND YACHT SUPERINTENDENT AND DESIGNER. Age 34; married; has had about fifteen years' experience in some of the best known launch and yacht building establishments in the country. Application No. 62.

LEADING DRAFTSMAN OR SUPERINTENDING ENGINEERING FOR STEAMSHIP LINE. Age 34; married; studied Massachusetts Institute of Technology; 11 years' experience in drafting and other marine work. Application No. 53.

LOFTSMAN. Age 33; single; has had eight years' experience as loftsman, foreman, and draftsman. Application No. 44.

MARINE MAN, EXPERIENCED, with excellent recommendations seeks outside position in shipyard or to represent some manufacturing concern or launch builder; is 39 years old and single. Application No. 78.

MASTER OF STEAM YACHT. Age 37; married; born in Norway; has license as master and pilot on ocean steamer; has commanded several well-known yachts. Application No. 40.

MASTER OF SHIP OR YACHT. Age 40; 7 years' experience; has first class master's license for all ocean and coastwise steamers and pilot for most harbors on the coast. Application No. 39.

MASTER OR PIER SUPERINTENDENT. Age 38; has spent whole life at sea and has British Extra and American master's certificate; pilot New York and San Francisco; experience in handling men and cargoes. Application No. 35.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line or fraction thereof, for the first insertion, and twenty-five cents per line for each subsequent insertion. Lines average ten words each. The heading counts as a line, as does also the address.

CANAL BOATS WANTED.

Parties desiring to sell crafts of the steam canal-boat or barge type, can effect sale by communicating with MONTGOMERY H. CLARK, 45 Broadway, New York.

Removal notice.—Queen & Company, makers of scientific instruments, Philadelphia, Pa., have removed their instrument factory from Filbert street to larger quarters in the Cornelius building, 817-831 Cherry street.

The Goldschmidt Thermit Company, 43 Exchange Place, New York city, reports that the United States government has asked it to present the company's exhibition at the World's fair, St. Louis, which was awarded a grand prize, to the national museum at Washington, D. C.

The Submarine Signal Company.—At a meeting of the Submarine Signal Company, at Portland, Me., officers and directors were chosen for the ensuing year. The company is pushing matters, and has contracted with the Canadian government for the protection of the Canadian coast. It is installing the fifty bells recently ordered by the Canadian government as fast as possible. It is also putting bells on the Portland lightship, Boston lightship, in Pollock Rip shoals, Vineyard Sound, Nantucket shoals, Brenton's Reef, Cornfield shoals lightship, Fire Island, Sandy Hook, and Overfalls, Philadelphia.

MASTER AND PILOT. Age 44; single; 11 years' experience; has license for 500 tons as master and pilot ocean and inland for New York, New Haven, and New London districts. Application No. 20.

OILER. Who has had experience on one of the well-known coastwise lines seeks position. Application No. 64.

OILER seeks position to learn marine engineering; is single; 22 years old; well educated and has had considerable mechanical experience. Application No. 77.

SHIP RIGGER. Who has had many years' experience in ship work both on board ship and in shipyards. Application No. 41.

SHIPWRIGHT, PRACTICAL, 48 years old, 33 years of experience in shipyards seeks position. Is competent to take charge of the building of all classes of vessels in wood from the mold loft to completion. Understands Spanish sufficiently to direct a force of men. Application No. 91.

SUPERINTENDENT FOR STEAMSHIP COMPANY. Age 29; married; experienced in hull and engine drafting. Application No. 37.

SUPERINTENDING ENGINEER, CHIEF DRAFTSMAN, ESTIMATOR OR SURVEYOR. Age 34; married; born and educated in Scotland; 15 years' experience in Scotland, Ireland and this country. Application No. 46.

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Will Hold Highest Pressure.

Don't have to Use Wire and Cloth to Hold

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The Eclipse Sectional Rainbow Gasket

3/8 in., 1/2 in., 5/8 in. } **For Hand Holes.**

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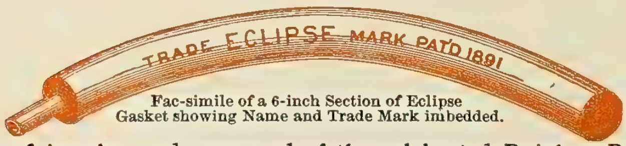

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The Eclipse Gasket is red in color, and composed of the celebrated Rainbow Packing Compound. It will not harden under any degree of heat, or blow out under the highest pressure, and can be taken out and repeatedly replaced. Joints can be made in from three to five minutes.

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ADDRESSES OF CORRESPONDING SECRETARIES.

No. 1, W. D. Blaicher, 10 Exchange St., Buffalo, N. Y.
" 2, Wm. Kelly, 11 Wall St., Cleveland, O.
" 3, A. L. Jones, 289 Champlain St., Detroit, Mich.
" 4, James A. Macauley, 5802 Indiana Ave., Chicago, Ill.
" 5, Otto Boettger, 1035 E. Hopkins Ave., Baltimore, Md.
" 6, Wm. Arste, 322 Pine St., St. Louis, Mo.
" 7, Wm. T. McElwee, Box 1556, Portland, Me.
" 9, Wm. Bridges, 784 1-2 12th St., Milwaukee, Wis.
" 13, John G. Paulding, 1746 Tulip St., Philadelphia, Pa.
" 14, Joseph F. Dumas, 403 Dauphin St., Mobile, Ala.
" 15, R. L. Skinner, 622 Louisa St., New Orleans, La.
" 17, Jas. D. Robinson, 6th and Columbia Sts., Newport, Ky.
" 18, Wm. Hurst, 715 Walnut St., Cairo, Ill.
" 20, Jos. B. Barry, 206 Keel St., Memphis, Tenn.
" 21, J. H. Foley, 206 N. Mulberry St., Vicksburg, Miss.
" 23, Wm. R. Lewis, 213 E. Front St., Jeffersonville, Ind.
" 24, Hugh L. Edwards, 511 Washington St., Paducah, Ky.
" 26, T. H. Kirkbridge, 228 Bond St., Evansville, Ind.
" 27, L. C. Schwall, 598 S. Madison St., Bay City, Mich.
" 29, James R. Sutherland, Charleston, W. Va.
" 30, E. R. Humphrey, 21 State St., Pittsburg, Pa.
" 33, James J. Waters, 283 Hudson St., New York, N. Y.
" 35, William M. Coombs, 36 East St., San Francisco, Cal.
" 36, Jos. Thomas, 57 Sea St., New Haven, Conn.
" 37, John B. Bender, 1215 Evesham Ave., Toledo, Ohio.
" 38, C. H. Wolford, 73 Starr Boyd Bldg., Seattle, Wash.
" 39, Frank Feeney, 460 E. 12th St., Erie, Pa.
" 40, Chas. Drouet, 1003 Ave. I, Galveston, Tex.
" 41, W. H. Marshall, 343 Holladay St., Portland, Ore.
" 42, Jas. Manning, 802 E. Duval St., Jacksonville, Fla.
" 43, A. J. Wilson, 1327 La Peer Ave., Port Huron, Mich.
" 44, Chas. J. Sullivan, 480 1st St., Manistee, Mich.
" 45, W. L. Salter, care O. S. S. Co., Savannah, Ga.
" 46, D. W. Farrell, Clayton, N. Y.
" 47, J. R. Cook, Sault Ste. Marie, Mich.
" 48, Alfred Hegemer, 140 E. Park St., Sandusky, O.
" 51, H. S. Connell, 12 Ranson St., Muskegon, Mich.
" 53, Harry Stone, Box 445, Marine City, Mich.
" 55, Archie Stalker, Box 883, Cheboygan, Mich.
" 57, E. B. Meeker, 71 Abeel St., Kingston, N. Y.
" 58, E. Capers Haselden, Box 31, Georgetown, S. C.
" 59, George F. Keating, 74 Webster St., E. Boston, Mass.
" 62, N. S. Lawrence, 30 Connecticut Ave., New London, Conn.
" 63, M. J. Burke, 152 Sheridan Ave., Albany, N. Y.
" 65, W. C. Palmer, care Consumers' Coal Co., Charleston, S. C.
" 67, James K. Dole, Saugatuck, Mich.
" 70, Charles T. Smith, 665 Commercial St., Astoria, Ore.
" 72, Wm. T. Findlay, 130 W. Bridge St., Oswego, N. Y.
" 73, E. M. Donahue, 1308 Cherry St., Green Bay, Wis.
" 75, Wm. D. Hemenway, Alexandria Bay, N. Y.
" 76, Orson Vanderhoef, Grand Haven, Mich.
" 77, John P. Hall, 1215 Huron St., Manitowac, Wis.
" 78, J. P. Burg, 2722 Minnesota Ave., Duluth, Minn.
" 80, Edward S. Welch, 338 Hamilton St., Albany, N. Y.
" 81, Jas. L. Sweeney, 206 E. Sarragosa St., Pensacola, Fla.
" 82, Fred H. Gowell, 427 Middle St., Bath, Me.
" 85, John A. Packard, 623 Merchant St., Alpena, Mich.
" 86, Sherman A. Smith, 737 Menekaunee Ave., Marinetta, Wis.
" 87, George B. Milne, 809 Fourth St., Detroit, Mich.
" 88, C. O. Chapman, S. B. Canal, Sturgeon Bay, Wis.
" 89, Geo. E. Willard, 4 Isabella St., Ogdensburg, N. Y.
" 91, A. L. McLaren, 130 W. Walnut St., Ashtabula, O.
" 92, Jos. D. Budd, Box 50, Sta. I, Saginaw, W. S., Mich.
" 93, W. J. Cook, 2220 G. St., N. W., Washington, D. C.
" 94, George R. Jones, Box 222, Washington, N. C.
" 95, P. J. McMahon, Box 199, Key West, Fla.
" 98, C. N. Vosburg, 6323 Patton St., New Orleans, La.
" 100, H. F. Mocine, Honolulu, H. I.
" 101, J. K. Cotton, Box 765, Norfolk, Va.
" 102, Fred. W. Linsemeyer, 210 Clinton St., South Haven, Mich.
" 103, A. E. Pittman, Box 378, New Bern, N. C.

TRADE PUBLICATIONS.

The April issue of *Graphite*, published by the Joseph Dixon Crucible Company, Jersey City, N. J., contains illustrations and descriptions of many important buildings of all classes in various parts of the United States upon which Dixon's silica-graphite has been used. Numerous testimonials of the paint are published in this number, among them being the following from Charles Daly, London, Eng.: "I painted the boiler and furnace door of my steam-yacht *Gazelle* with your graphite paint, and it lasted two seasons without touching."

A new book for naval constructors and engineers.—The Norman W. Henley Publishing Company, 132 Nassau street, New York city, is bringing out the American edition of MARINE ENGINES AND BOILERS, a hand-book for students, engineers, and naval constructors. This is a volume of 772 pages with 550 illustrations, including 17 folding plates and numerous tables. It is based on the well-known work by Dr. G. Bauer, Engineer-in-Chief of the Vulcan Works, Stettin, Germany. The tables have been reduced to English standards. Only modern types of marine engines and boilers are dealt with and the greater part of the book is based upon results obtained in actual practice. Price $9.00.

"At Last a Gas Whistle" is the title of a booklet published by the Gas Engine Whistle Company, 1133 Broadway, New York city. The statement is made in this booklet that "The only whistle that will produce a strong, clear blast, one that can be heard for two miles, is the Watres gas engine whistle. This whistle is blown by gas. A minute quantity of exploded gas is taken by each explosion and is stored in a tank. It takes little from the power but gives plenty of pressure for a long, strong blow. The result is what is known as a two-inch chime whistle. It blows simultaneously three tones of the chromatic scale, and while loud and strong, it is neither harsh nor discordant. It weighs but 80 pounds. Anyone who can use a pipe wrench can install it."

Centrifugal pumping machinery and marine engines, are the subject of a 90-page illustrated catalogue issued by the Morris Machine Works, Baldwinsville, N. Y. This catalogue states that the Morris centrifugal pumps and marine engines have been on the market over 40 years, and that during that time the company has built nearly 30,000 pumping outfits of different sizes and types. The catalogue illustrates and describes not only the company's regular line of pumps but also a part of the machinery the company builds. The half-tone cuts are especially good. A few of the many illustrations show a pair of 32-inch dredging pumps used by the government in the Mississippi River; a 36-inch pumping engine, capacity 35,000 per minute against a 28-foot head; various types of vertical pumps; several double section pumps; all-composition pumps with direct-connected compound engines; electrically-driven pumps, and various types of marine engines. The catalogue contains, moreover, several pages containing information on friction and power, some useful data in hydraulics, and other information.

Gasoline engines and launches are described in a handsomely illustrated catalogue issued by the Racine Boat Manufacturing Company, Muskegon, Mich. Regarding its "Twentieth Century" motor boat the catalogue states that it is the outcome of twenty-two years of experience; that it is a safe and handsome family launch built to last for years and still look well. In building this boat the company had in mind the fact that few motor-boat owners are familiar with the use of machinery. For this reason the boat was made simple in construction and with an engine easy to understand. The catalogue says: "While we have made the construction as simple as possible we have not done so at the sacrifice of power." This catalogue also illustrates and describes the company's various types of gas engines and their appurtenances, together with boat fittings such as life preservers and ring buoys. The company issues a number of other catalogues, among which are, No. 2, devoted to row-boats, hunting-boats, sail-boats, canoes, etc.; and No. 3, describing steam and sailing yachts, engines, boilers, shallow-draft turbine steamers, etc. Either of these catalogues will be forwarded upon receipt of five cents for postage.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS.

314 Madison Avenue, New York City.

President, JOHN J. AMORY.
First Vice-President, H. A. LOZIER, JR.
Second Vice-President, CHARLES A. STRELINGER.
Third Vice-President, HENRY R. SUTPHEN.
Treasurer, J. S. BUNTING.
Secretary, HUGH S. GAMBEL.
Executive Committee, JOHN J. AMORY, Chairman: 1908, J. B. SMALLEY, JAMES CRAIG, JR., C. L. SNYDER, EUGENE A. RIOTTE, A. MASSENAT. 1907, JOHN J. AMORY, H. A. LOZIER, JR., J. S. BUNTING, H. N. WHITTELSEY, CHARLES A. STRELINGER. 1906, S. J. MATTHEWS, A. SNYDER, H. H. BRAUTIGAM, ALBERT E. ELDRIDGE, HENRY R. SUTPHEN.

Cold chisels and other tools are the subject of a 40-page catalogue issued by W. H. Anderson & Sons, Detroit, Mich. The catalogue states "the fact that we have been making tools for more than 33 years is an indication that we do good work."

"Engineers' Chums" is the title of a pamphlet issued by the Mound Tool and Scraper Company, 712 Howard street, St. Louis, Mo. Cold-chisels, packing tools, and a new portable file are described and illustrated. These portable files are made especially for filing valve seats in pumps and engines. Regarding the packing tools the pamphlet states that they will go into any valve-rod pump or engine stuffing-box. They are warranted not to break. The pamphlet will be sent free to all applicants mentioning Marine Engineering.

Boiler-tube cleaners.—The Criss-Cross tube cleaner for fire-tube boilers, manufactured by the Criss-Cross Tube Cleaner Company, Clinton, Mass., is described in a booklet mailed by this company. In designing this tube cleaner the company had in view a cleaner that should enter the tube without injuring the flanges and that should have a large number of independent, oblique, serrated cleaning edges placed at right angles to the surface of the tubes; the crumbled scale is discharged from the tube when the cleaner is drawn back as well as when pushed forward. The question is asked in this catalogue: "When $12 worth of coal is consumed daily under the boiler with fouled or half-cleaned tubes, how long will it take to save the cost of a good cleaner?" The answer is given: "One day's run."

Plastic metallic packing, manufactured by the Steel Mill Packing Company, Detroit, Mich., is described in a catalogue the company is distributing. This packing is designed for use on high-pressure engines, steam hammers, air compressors, etc. The catalogue states that it is an alloy of the best anti-friction metals, made hard enough for durability, but not hard enough to score steel or brass rods. The metals are made into shreds of assorted sizes which weave together under pressure of gland, forming a packing of great strength. The shreds are cushioned with a compound of lubricating materials which under pressure become incorporated in the packing, making a constant supply of lubrication. Numerous testimonials are contained in the catalogue from satisfied users of this packing.

Marine gasoline engines and propeller wheels are illustrated in a catalogue issued by the Spaulding Gas Engine Works, St. Joseph, Mich. The catalogue states that the design of the engine is up-to-date in every respect. There is a great demand, so the catalogue states, for a motor of medium proportions—one that is simple and reliable and devoid of all complicated parts. The Spaulding engine, it is claimed, embodies simplicity of construction, positive oiling in all frictional parts, variation in speed, quietness of operation, solid cylinder heads, and a new patent igniter. The company has received the following testimonial from Captain H. O. Wilson, St. Joseph, Mich.: "The engine I purchased from you some years ago has been in continuous use since, and it has performed to my entire satisfaction. Two years ago I had in my employ a man thoroughly acquainted with gas engines and their construction. While he was with me I thought it would be well to have him go over the engine and make any repairs that were necessary, as there had never been one cent spent upon it for repairs up to that time. To my surprise he reported to me that there was nothing about it to repair. The engine was put together again as found, and has not given me a moment's trouble since."

Marine and stationary fuel saving and smoke-consuming appliances are the subject of an illustrated 22-page catalogue issued by the James Reilly Repair and Supply Company, 229 West street, New York city. Regarding the company's "Multicoil" marine feed-water heater, the catalogue states that this feed-water heater consists of a cylindrical steel shell with bumped steel heads fitted with an annular gun-metal manifold top and bottom, the two being connected by a series of helical copper coils by means of ground joint unions. The feed inlet leads to the bottom manifold and feed outlet leads from upper manifold. The auxiliary exhaust line is led to the top of the heater and the drain connection at bottom branches into pipes, one of which leads the condensation to the feed tank, the latter pipe being controlled by a valve, and the other branch leads to the main engine condenser and is fitted with an automatic relief valve which maintains a pressure of the exhaust in the heater shell. Under regular working conditions the feed water in the coils of the heater will absorb the heat of the auxiliary exhaust and discharge the condensation to the feed tank. In this manner the main condenser will be entirely relieved of the auxiliary exhaust. The "Multicoil" feed-water heaters are stated to be absolutely automatic, and after being once adjusted they require no further attention. The catalogue gives a long list of steamships and yachts on which the company's feed-water heaters are in use.

."**Pioneers and Leaders**" is the title of a booklet issued by the New York Belting and Packing Company, manufacturers of mechanical rubber goods, 91 Chambers street, New York city. Interlocking rubber belting for yachts, battleships, and other craft; rubber belting hose; sheet packing; piston and valve-rod packing, and rubber tubing, are among the specialties this company manufactures.

Metal expanding tools and machinery, invented by Luther D. Lovekin, are described in an illustrated catalogue published by the Scully Steel and Iron Company, Chicago, Ill., exclusive sellers of the Lovekin tools. Among the tools and machines described are pipe flanging and expanding machines, valve-seat expanders, sleeve-jointed machines, and flue-expanding tools. These machines were invented by Mr. Lovekin to meet the demands of work in hand while he was connected with one of the largest shipbuilding concerns in the United States.

Electric generating sets are the subject of Bulletin No. 63, issued by the B. F. Sturtevant Company, Hyde Park, Mass. These generating sets range from 3 to 100 Kw. in output, the smallest size being driven by a 3 1-2 by 3 vertical engine and the largest by a 14 by 14 horizontal center-crank engine; a separate series ranging from 7 1-2 to 100 Kw. is equipped with vertical compound engines. All the types of engines illustrated are inclosed and arranged with water-shed partitions to prevent the water from the piston-rod stuffing box reaching the interior of the frame. All interior bearings are supplied with oil by a system of forced lubrication, thereby securing a mechanical efficiency, so the bulletin states, in excess of 90 percent. Many of the generating sets in vertical, simple, and compound types have been designed to meet the specifications of the United States Navy Department.

"**Our electric motors** and generators are running in every state in the Union." is a statement made on a calendar mailing card issued by the Crocker-Wheeler Company, Ampere, N. J.

Marine and stationary motors, propeller wheels, and reverse clutches, are the subject of an illustrated catalogue issued by the Tuck Petroleum Motor Company, Third avenue and Twenty-second street, Brooklyn, N. Y.

"**Circulation of steam** for heating purposes at or below the pressure of the atmosphere," a paper read before the American Society of Heating and Ventilating Engineers by Reginald Pelham Bolton, has been reprinted by Warren Webster & Company, Camden, N. J., who manufacture and install a system of steam heating.

"**Steam Specialties**" is the subject of illustrated Catalogue No. 9, issued by the Wright Manufacturing Company, Detroit, Mich. Among the devices described are water columns, steam traps, scale separators, and exhaust heads. The catalogue states, "Our entire efforts are concentrated on the specialties herein described, each of which has been made the subject of careful study and experiment."

Users of pneumatic riveters for boiler, tank, and ship work, should send to the Hanna Engineering Works, 820 Elston avenue, Chicago, Ill., for a copy of this company's catalogue devoted to portable and stationary pneumatic compression yoke riveters. The catalogue comprises 16 pages, and contains a number of large and excellent engravings of the several types of riveters which this company manufactures.

A free copy of catalogue No. 70 will be sent to every reader of Marine Engineering by Walter MacLeod & Company, 213 East Pearl street, Cincinnati, O. The catalogue is devoted to illustrating and describing a number of important specialties such as oil forges and furnaces, oil burners for lighting and heating, automatic machines for painting and whitewashing, sand-blast machines, acetylene lights, and lamps of various designs, etc.

"**An Ounce of Prevention is Worth a Pound of Cure**" is the title of a book issued by the International Boiler Compound Company, 47 Market street, Chicago, Ill. In this case the ounce of prevention is the International boiler compound, which, the booklet states, saves the boiler, saves labor, saves fuel, and prevents explosion. A trial sample of this compound will be sent free to those mentioning Marine Engineering.

Marine gasoline motors are illustrated and described in Circular No. 7, issued by the Toquet Motor Company, Metropolitan Building, New York city. In designing this motor the company had in view the making of an engine strong, compact, and symmetrical, with every wearing surface of ample size, and every fastening secure. The construction, the catalogue states, is the best that special machinery and modern methods can produce. All parts are interchangeable.

Pipe and boiler coverings are the subject of a 50-page illustrated catalogue issued by the Philip Carey Manufacturing Company, Lockland, O. The claim is made for these coverings that they are absolutely fire-proof; that they confine the heat to the pipes or boiler, thus preventing loss through radiation; that they prevent the condensation of steam, thus avoiding the necessity of excessive firing and reducing the amount of fuel consumed; that the amount of fuel saved in this manner will within six or eight months more than pay for the cost of the coverings; that they outlast the surfaces to which they are applied, so that the saving year after year becomes an annual dividend of at least 100 percent on the original cost; that they are used by thousands of steam users throughout the country.

Anti-friction bearings, bronzes, steel, copper, and other metals manufactured by the Buda Foundry and Manufacturing Company, Railway Exchange Building, Chicago, Ill., are described in Bulletin No. 11 issued by this company.

Gasoline marine motors are described in a folder issued by the Duryea Power Company, Reading, Pa. This company makes a specialty of steel hulls for motor boats, which, it states, when built with suitable air chambers, are more buoyant than wood, less liable to damage, more easily repaired, cheaper to buy, and cheaper to maintain. A 21-foot hull containing two people and driven by this company's regular triple motor, recently went several hours at the rate of 15 miles per hour, so the folder states.

The Bullard automatic wrench.—This wrench is described in an illustrated pamphlet published by the Bullard Automatic Wrench Company, Providence, R. I. The catalogue states that the Bullard wrench is so constructed as to make it wear evenly, the strain on the jaws being distributed by use on different sized pipe, thereby increasing the durability of the wrench. It is manufactured from the best drop forged steel and has jaws of high-grade tool steel.

Gas engines, propeller wheels, reverse gears, batteries, coils and fittings, are described in an illustrated folder issued by McDonald & Erickson, 36 West Randolph street, Chicago, Ill. The folder states that upon examination of the McDonald & Erickson engine one is struck with the absence of complicated parts. The engine has no valves, springs, cams, or small triggers to get out of adjustment. All working parts are easy of access and all parts are made in duplicate and are interchangeable. The blades of the propeller are interdependent, interchangeable, and easily removed or replaced.

"The Progress Reporter," an illustrated magazine of about 50 pages, is issued every few weeks by the Niles-Bement-Pond Company, 136 Liberty street, New York city. The object of the publication is to keep the employees of the company and the public in general informed regarding new machines and devices which are constantly brought out. Any one interested will be put on the free mailing list upon request. The April issue is devoted to illustrating and describing the Schnectady works of the American Locomotive Company.

The Crosby steam engine indicator and the Crosby reducing wheel, are described in a folder issued by the Crosby Steam Gauge and Valve Company, Boston, Mass. The folder asserts that to obtain trustworthy results on high-speed engines the indicator must be light and possess a perfect adjustment of all moving parts, together with simplicity of construction and convenience of manipulation. These qualities the circular states are all found in the Crosby indicator. Regarding the reducing wheel, it is asserted that this wheel is adapted to receive any steam-engine indicator or indicator cock on all steam engines within the limits of stroke of 10 inches and 72 inches.

"Graphoil" lubricators, manufactured by the Comstock Engine Company, 49 Clymer street, Brooklyn, N. Y., are the subject of a booklet this company is distributing. Regarding the use of graphite for lubrication, the catalogue states that as prepared by the Joseph Dixon Crucible Company, Jersey City, N. J., it has been favorably known for years, having the indorsement of thousands of practical engineers. Various mechanical devices have been employed for feeding it but none of them were satisfactory. The Graphoil lubricators are presented in the belief that they will feed a high-class lubricating material in the best possible way.

"A Few physical, competitive and service tests to Falls Hollow and solid staybolt iron," are published in a 32-page folder issued by the Falls Hollows Staybolt Company, Cuyahoga Falls, O. Among the advantages of the Falls Hollow staybolts claimed in this folder are greater tensile strength, saving of material, greater opportunity for detection of breakage, and improved combustion. The Falls Hollow staybolt iron, it is stated, is now the standard with many of the leading railway and boiler manufacturers of the United States, Canada, Mexico, Japan, Norway, Brazil, and many other foreign countries. "The Experience of an Expert on Falls Hollow Iron," and copies of orders from all over the world, are also contained in this folder.

"Boiler Scale and its Prevention."—A description of the method of cleaning steam boilers with the automatic boiler cleaner made by the Buckeye Boiler Skimmer Company, 519 Colburn street, Toledo, O., together with numerous testimonials from purchasers, is the subject of a 32-page catalogue this company is distributing. The device is intended to remove impurities from the water in marine and stationary boilers and return the purified water at slightly reduced temperature to the boiler, thus preventing the formation of scale and sediment, thereby increasing the steam capacity and diminishing operating expenses, besides prolonging the life of the boiler, preventing foaming and lessening the danger of explosion. The device is said to be of simple construction and easily operated.

The Wieland 8-inch pipe threading and cutting machine, with adjustable expanding chasers, is described in an illustrated folder issued by the Standard Engineering Company, Elwood City, Pa.

The steam regulating devices and steam pumps manufactured by the Mason Regulator Company, 158 Summer street, Boston, Mass., are described in an illustrated catalogue this company is issuing. Among the steam specialties described and illustrated are reducing valves, pump-pressure regulators, automatic belt shifters, balance valves, pump governors, water reducing valves, and steam pumps.

Crane steam and oil separators.—Crane Company, Chicago, Ill., has issued its advanced Circular No. 01 of Crane steam and oil separators for the separation of water from live steam, and the elimination of oil from exhaust steam. These separators are made in sizes from one to thirty inches, in horizontal, vertical angle, and distributing types. The circular contains 26 pages, is fully illustrated, and will be forwarded free upon request.

"Fire-proofing Hulls" is the subject of a folder issued by Toch Brothers, 468 West Broadway, New York city. This folder states: "We have fire-proofed many ferryboats in New York harbor by the use of 'Tockolith.' 'Tockolith' is a tricalcic silicate cement which is mixed with water. We will send you working samples of 'Tockolith' free upon application. It can be used on damp surfaces, and this makes it set harder. One of our largest ferry companies has adopted this compound with great success."

Ice and refrigerating machines are described in an illustrated catalogue issued by the Kroeschell Brothers' Ice Machine Company, 29 East Erie street, Chicago, Ill. Regarding the North Pole ice and refrigerating machine, it is stated that they are very compact, making them suitable for use on board ship. They can be shipped ready to begin immediate operation upon making the necessary bolt and pipe connections, and may be operated by steam, electricity, or gas engines.

"Upsetting Rivets" is the title of a booklet issued by John F. Allen, 370 Gerard avenue, New York city. A number of testimonials of the Allen boiler riveting machine appear, among them being one from the Portland Company, Portland, Me.: "The 72-inch boiler riveter bought from you has given satisfaction. We are able to rivet small boilers, which will not go over the stake on the yoke riveter, very satisfactorily, although we have been unable to do steam work with the ordinary yoke riveter."

Vol. I, No. 2, of "Air Power," published by the Rand Drill Company, 128 Broadway, New York city, manufacturer of pneumatic tools and air compressors, contains a number of illustrated articles of interest to engineers. Among these are articles describing a natural-gas pumping plant at Hundred, Va., "Graphics of Boyle's Law," and "Economy in the Operation of Coal Mines and Power Plants." The magazine states that "'Air Power' does not contain fiction. If we say that a compressor has been installed at a certain point which delivers 5,000 cubic feet of air per minute, you can take it to be a fact."

"The New Yankee Drill Grinder and Other Good Tools" is the title of a catalogue received from the Wilmarth & Morman Company, Grand Rapids, Mich. The "New Yankee" drill grinder is made in many styles, and each is described in this catalogue. These grinders have no gauge jaws and no calipering devices. The holder is never moved except to follow the wear of the wheel. It is claimed that these grinders can stand very high speed, require only light feed pressure, produce clean chips, true straight holes, run a long time between grinding, and rarely break. Besides the drill grinder this company manufactures friction counter-shafts, arbor presses, and the Nelson loose pulley. Anyone mentioning Marine Engineering can secure a copy of this catalogue.

BUSINESS NOTES.

An electrical exposition.—There will be held at Madison Square Garden, New York city, from December 12 to 23, 1905, an electrical trade show, wherein are to be exhibited the appliances and developments of electrical engineering. Information concerning the exhibition may be obtained from G. H. Sever, Director of Exhibits, 26 Cortlandt street, New York city.

New boiler works.—The Robb-Mumford Boiler Company, Amherst, Nova Scotia, is building a large plant at South Framingham, Mass., and has bought the boiler works of Edward Kendall & Sons, Cambridge, Mass. This latter plant will be transferred to South Framingham when the new works are completed. The new plant will be located on the line of the Boston and Albany Railroad, and will be equipped with all up-to-date apparatus. According to the present plans the establishment will consist of a main shop 300 by 150 feet and an office building.

Metallic packing for gas engines is the latest product of the France Packing Company, Tacony, Philadelphia, Pa. The company has long been experimenting with such a packing, and now claims to have achieved complete success. This packing is to be sold under the same conditions governing the other outputs of the company's plant—the coupon system—by which any engineer, master mechanic or superintendent can equip his entire plant with tools free of charge. For particulars see the advertisement of the France Packing Company on page 17 of Marine Engineering.

The Susquehanna Marine Works Company, Havre de Grace, Md., announces that it designs and builds speed launches, auto boats, gasoline power fishing boats and oyster dredges, sailing vessels and steam tugs. The company states "our experience with marine gasoline motors enables us to give expert advice in selecting a power suited to the work. No matter what kind of an engine you have in view, let us name you a price on your boat with your selection installed. We can buy the engine and save you money. If you are undecided about the engine, we will give you the advantage of our experience and advice."

A prosperous roller-bearing company.—S. S. Eveland, vice-president and general manager of the Standard Roller Bearing Company, 48th street and Girard avenue, Philadelphia, Pa., has purchased for his company the plant of the Federal Manufacturing Company, Cleveland, O., which has manufactured steel balls for twenty years. The Standard Roller Bearing Company a year ago bought the ball business of the Grant Ball Company, Cleveland, O., and Franklin, Pa., and transferred it to Philadelphia. These consolidations give the company a capacity of more than 500,000,000 balls a year. This great enlargement of the Standard Roller Bearing Company has all taken place since Mr. Eveland became vice-president and general manager.

The H. W. Johns-Manville Company, 100 William street, New York city, manufacturer of asbestos materials, has appointed T. T. Lyman General Sales Manager.

Pneumatic tools and appliances are manufactured by the Aurora Automatic Machinery Company, Aurora, Ill. Regarding its reversible drills the company states that they can be reversed at full speed, a twist of the wrist stopping, starting, or reversing them.

Terry & Company, Detroit, Mich., general Eastern agents of the Lamb Boat and Engine Company, Clinton, Iowa, have leased the store formerly occupied by Toppin Brothers, 92 Chambers street, New York, N. Y., and will put in a complete line of yacht hardware.

The following vessels have been classed and rated by the American Bureau of Shipping, 66 Beaver street, New York city: American screw *City of Peking,* American screw *Ordnance,* American schooner *Governor Powers,* American tern *Greenleaf Johnson,* American barge *Somerset,* Danish bark *Erik,* and Swedish bark *Malvina.*

Life preserver tests.—The recent tests made by the United States Board of Supervisors regarding life preservers resulted in showing that the life preservers made from the blocks of Acme compressed cork by the Armstrong Cork Company, Pittsburg, Pa., were of superior quality.

The Niles-Bement-Pond Company, manufacturer of machine tools, has moved from 136 Liberty street, and has leased an entire floor in the new Trinity Building at 111 Broadway, New York city. This company employs about 5,000 men, having two factories in Philadelphia, Pa., one in Hamilton, O., and one in Plainfield, N. J., besides owning the Pratt & Whitney Company, Hartford,

Engines for the Pennsylvania Railroad launch.—The 70-foot launch which is now being built by the Pennsylvania Railroad Company for use at Ocean City, N. J., is fitted with engines built by W. D. Forbes Company, Hoboken, N. J. This company has built the machinery for the entire fleet plying between Ocean City and Longport. The engines are compound, 8 by 16 by 10.

Wilson & Silsby, sail makers, Rowe's Wharf, Boston, Mass., report the following orders for sails: George E. Darling, Providence, R. I., mainsail for cat boat; Robert Toland, Philadelphia, Pa., suit of sails for *Pellegrina;* Sumner Foster, suit of sails for 22-footer; A. Bryan Alley, New York city, suit of sails for 21-footer; Frank T. Christy, Rochester, N. Y., suit of sails for 30-footer; George Lawley & Son Corp., South Boston, Mass., suit of sails for 18-footer; Cary, Smith & Ferris, New York city, suit of sails for 90-footer; John Cox & Company, Boston, Mass., two suit of sails for 35-ton lobster smacks; George Lawley & Son Corp., suit of sails for 35-foot schooner; W. H. Winship, Boston, Mass., suit of sails for 25 footer; John F. Washburn, Vineyard, Mass., mainsail for cat-boat; W. B. Rogers, Boston, Mass., three suits of sails for 18-footers; Henry A. Morss, Boston, Mass., suit of sails for *Cossack;* George B. Gale, Atlantic City, N. J., suit of sails for 50-foot sloop; George B. Gale, Atlantic City, N. J., jib for *Mehrer, II;* H. T. Schmidt, Detroit, Mich., suit of sails for *Spray;* J. E. Ramaley, White Bear, Minn., two suits of sails for 17-footers; David B Ogden, New York city, suit of sails for *Hadassah;* James E. Graves, Marblehead, Mass., suit of sails for boat sent to Germany; J. O. Johnson, White Bear Lake, Minn., one suit of sails for 20-footer; J. O. Johnson, White Bear Lake, Minn., four suits of sails for 17-footer; Kee Lox Manufacturing Company, Rochester, N. Y., suit of sails for 30-footer *Kee Lox II;* Gardner & Cox, New York city, suit of sails for boat sent to Wiborg, Finland; A. F. Jennings, Detroit, Mich., suit of sails for steamer *Claire;* George Owen, Winthrop, Mass., two suits of sails for 21-footers; Harry Wahl, Wiborg, Finland, mainsail for cat-boat; C. C. Hanley, for A. C. Jones, suit of sails for 22-footer; William G. Burton, Tuckerton, N. J., mainsail for cat-boat; George Lawley & Son Corp., suit of sails for 95-footer for R. A. Rainey; W. D. Wood, Providence, R. I., mainsail for cat-boat; Frank S. Page, Norwalk, Conn., suit of sails for 21-footer; T. L. White, Manchester, Mass., two suits of sails for 18-footers; H. H. Landon, New York city, suit of sails for 15-footer; W. Morse Wilson, Buffalo, N. Y., suit of sails for 25-footer; Baker Construction Company, suit of sails for 18-footer; Tams, Lemoine & Crane, New York city, mainsail for yacht *Ailsa;* G. R. Liljegren, Gothenburg, Sweden, four suits of sails; George W. Lee, Ocean City, N. J., mainsail and jib; W. J. Schieffelin, New York city, suit of sails for 25-footer; George A. Suter, New Rochelle, N. Y., suit of sails for *Simiter;* William J. Wright, mainsail and jib; I. Bergmann, St. Petersburg, Russia, suit for 32-foot rater.

MARINE ENGINEERING EMPLOYMENT BUREAU

Full information regarding the purposes of this Bureau, together with instructions regarding registration, etc., furnished upon application to Marine Engineering Employment Bureau, 17 Battery Place, New York city.

All correspondence, concerning either vacancies or situations wanted, is strictly confidential.

MEN SEEKING POSITIONS

We have applications registered for positions as follows, and the references of each applicant have been carefully investigated:

ASSISTANT OR SUPERINTENDING ENGINEER to shipping concern or factory seeks position; is 30 years old, married, and has had several years experience at sea as chief engineer. Application No. 100.

BOILER-MAKER FOREMAN seeks position. Is at present foreman of railroad shops and has charge of nearly one hundred men; has had twelve years' experience as foreman; posted in the latest boiler practice; has best references as to ability and character; is 38 years old. Application No. 73.

BOILER-SHOP FOREMAN. Age 35; single; many years' experience in Navy Yard and leading shipyards. Application No. 59.

BOILER-SHOP FOREMAN. Age 37; single; 16 years' experience in boiler-shop work. Application No. 47.

CHIEF OR ASSISTANT CHIEF DRAFTSMAN—ENGINE. Age 33; married; has had sea experience and thirteen years as leading and chief draftsman of private and government shipyards. Application No. 25.

CHIEF DRAFTSMAN OR SUPERINTENDING ENGINEER seeks position. Has had extensive experience in several of the best known shipyards, and can furnish the best of references. Application No. 81.

CHIEF DRAFTSMAN OR CHECKER seeks position; is 36 years old; married; was with the Carnegie Steel Company for about three years; later with the National Steel Company, and with the American Bridge Company. Application No. 79.

DESIGNER, EXPERIENCED, of dredges and other types of vessels, seeks position; is 28 years old; has had 10 years of experience in Great Britain and this country in leading shipyards. Application No. 82.

DESIGNER AND DRAFTSMAN. Has had many years' experience in launch and river boat work. Designed some of the fastest river boats in the country. Application No. 61.

DRAFTSMAN, ENGINE AND BOILER. Age 30; unmarried; has Danish marine license; technical school graduate. Application No. 57.

DRAFTSMAN—HULL. Age 20; single; experienced in architectural work, but prefers marine drafting. Application No. 51.

DRAFTSMAN—HULL, OR INSPECTOR. Age 37; married; had experience both in government yards and private yards. Application No. 30.

DRAFTSMAN—HULL. Age 22; single; born in Norway; studied Technical schools in Norway and Germany; experience as draftsman, also as shipfitter. Application No. 31.

DRAFTSMAN—HULL. Age 27; single; has had six years' experience on government work and in private yards; graduate of Webb's Academy. Application No. 65.

DRAFTSMAN—HULL AND ENGINE. Age 26; single; graduated Webb Academy; has had four years' experience in navy yard work; desires connection with private shipyard. Application No. 41.

DRAFTSMAN—ENGINE, STEAM OR GAS. Forty-three years old; single; born in Germany; has had extensive experience in designing and drafting; has had sea experience. Application No. 32.

DRAFTSMAN—MARINE. Age 34; married; accustomed to intricate drafting work. Application No. 50.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

12 West 31st Street, New York.

President, FRANCIS T. BOWLES.
Secretary-Treasurer, W. J. BAXTER.
Executive Committee, LEWIS NIXON, EDWIN A. STEVENS, HARRINGTON PUTNAM, STEVENSON TAYLOR. *Ex-officio*, FRANCIS T. BOWLES, W. J. BAXTER.

AMERICAN SOCIETY OF NAVAL ENGINEERS.

Navy Department, Washington, D. C.

President, Commander A. F. DIXON, U.S.N.
Secretary-Treasurer, Lieutenant CHARLES K. MALLORY, U.S.N. (retired.)
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" 35, William M. Coombs, 36 East St., San Francisco, Cal.
" 36, Jos. Thomas, 57 Sea St., New Haven, Conn.
" 37, John B. Bender, 1215 Evesham Ave., Toledo, Ohio.
" 38, C. H. Wolford, 73 Starr Boyd Bldg., Seattle, Wash.
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" 40, Chas. Drouet, 1003 Ave. I, Galveston, Tex.
" 41, W. H. Marshall, 343 Holladay St., Portland, Ore.
" 42, Jas. Manning, 802 E. Duval St., Jacksonville, Fla.
" 43, A. J. Wilson, 1327 La Peer Ave., Port Huron, Mich.
" 44, Chas. J. Sullivan, 480 1st St., Manistee, Mich.
" 45, W. L. Salter, care O. S. S. Co., Savannah, Ga.
" 46, D. W. Farrell, Clayton, N. Y.
" 47, J. R. Cook, Sault Ste. Marie, Mich.
" 48, Alfred Hegemer, 140 E. Park St., Sandusky, O.
" 51, H. S. Connell, 12 Ranson St., Muskegon, Mich.
" 53, Harry Stone, Box 445, Marine City, Mich.
" 55, Archie Stalker, Box 883, Cheboygan, Mich.
" 57, E. B. Meeker, 71 Abeel St., Kingston, N. Y.
" 58, E. Capers Haselden, Box 31, Georgetown, S. C.
" 59, George F. Keating, 74 Webster St., E. Boston, Mass.
" 62, N. S. Lawrence, 30 Connecticut Ave., New London, Conn.
" 63, M. J. Burke, 152 Sheridan Ave., Albany, N. Y.
" 65, W. C. Palmer, care Consumers' Coal Co., Charleston, S. C.
" 67, James K. Dole, Saugatuck, Mich.
" 70, Charles T. Smith, 665 Commercial St., Astoria, Ore.
" 72, Wm. T. Findlay, 130 W. Bridge St., Oswego, N. Y.
" 73, E. M. Donahue, 1308 Cherry St., Green Bay, Wis.
" 75, Wm. D. Hemenway, Alexandria Bay, N. Y.
" 76, Orson Vanderhoef, Grand Haven, Mich.
" 77, John P. Hall, 1215 Huron St., Manitowac, Wis.
" 78, J. P. Burg, 2722 Minnesota Ave., Duluth, Minn.
" 80, Edward S. Welch, 338 Hamilton St., Albany, N. Y.
" 81, Jas. L. Sweeney, 206 E. Sarragosa St., Pensacola, Fla.
" 82, Fred H. Gowell, 427 Middle St., Bath, Me.
" 85, John A. Packard, 623 Merchant St., Alpena, Mich.
" 86, Sherman A. Smith, 737 Menekaunee Ave., Marinetta, Wis.
" 87, George B. Milne, 809 Fourth St., Detroit, Mich.
" 88, C. O. Chapman, S. B. Canal, Sturgeon Bay, Wis.
" 89, Geo. E. Willard, 4 Isabella St., Ogdensburg, N. Y.
" 91, A. L. McLaren, 130 W. Walnut St., Ashtabula, O.
" 92, Jos. D. Budd, Box 50, Sta. I, Saginaw, W. S., Mich.
" 93, W. J. Cook, 2220 G. St., N. W., Washington, D. C.
" 94, George R. Jones, Box 222, Washington, N. C.
" 95, P. J. McMahon, Box 199, Key West, Fla.
" 98, C. N. Vosburg, 6323 Patton St., New Orleans, La.
" 100, H. F. Mocine, Honolulu, H. I.
" 101, J. K. Cotton, Box 765, Norfolk, Va.
" 102, Fred. W. Linsemeyer, 210 Clinton St., South Haven, Mich.
" 103, A. E. Pittman, Box 378, New Bern, N. C.

TRADE PUBLICATIONS.

A quick-action pipe wrench.—The pipe wrench manufactured by the Hammond Manufacturing Company, 32 Atlantic avenue, Boston, Mass., is described in a folder issued by this company. It states that a simple pressure of the thumb on the lever releases the jaw, allowing it to be instantly opened to its full width. This tool consists of very few parts, all of which are interchangeable. The inserted jaw is removable, and can be replaced at any time.

Pattern-shop equipment for wood and metal pattern work is described in illustrated catalogue No. 27, published by the Fox Machine Company, Grand Rapids, Mich. The catalogue states that as the company believes that a complete pattern-shop equipment catalogue will be appreciated, it has prepared this one for distribution, listing a full line of the tools the company puts out especially for pattern-work use. The company issues separate catalogues on general wood-working and machine tools, and will forward any of them free upon request.

Twist drills are the subject of an illustrated 22-page catalogue issued by the Lincoln-Williams Twist Drill Company, Taunton, Mass. Regarding its high-speed twist drills, the catalogue states: "The remarkable results obtained from high-speed steel made into lathe and planer tools, and the request of many customers that we make some twist drills from high-speed steel, induced us to experiment with some of the best-known brands. The results were marvelous, and were a revelation in drilling, not only to our customers but to ourselves." In addition to high-speed drills, the catalogue describes carbon steel tools such as shank drills, machine bitts, and taps and dies.

"Classified Mechanical Facts" is the title of a work published by the J. B. Lippincott Company, Washington square, Philadelphia, Pa. The object of the work, the company states, is to form a standard hand-book for the mechanical engineer and the designer of machinery, supplying in convenient form the general information which is constantly required but which cannot be memorized. The book treats on mathematics, mechanics, materials of engineering, strength of materials, machine design, heat, air, water, fuel, steam, steam boilers, steam engines, internal combustion motors, electric power, the cost of power, and works management.

Marine gasoline engines and launches are described and illustrated in a 36-page catalogue issued by the Frank M. Watkins Manufacturing Company, Cincinnati, O. The engines described in this catalogue are all of the two-cycle type. Although the company manufactures both two- and four-cycle engines, yet for use in small pleasure craft it recommends the two-cycle type. The company states that the material and workmanship in the construction of its engines are of the best obtainable. The cylinders are made from gray iron castings and the pistons are made of the same material and of a length which experience has shown to be most serviceable. The packing rings are of the snap-ring pattern made from special casts. The crank shafts are of forged steel and the crank-ring bearings are fitted with heavy phosphor bronze bushings; the connecting rods are also of phosphor bronze. The jump-spark system of ignition is used, and the engine is equipped with a spark-speed controller. The cylinders of the engines are encased with water jackets. Grease cups and lubricators are of the most up-to-date type. On sizes of engines of 3 1-2 horsepower and over the company furnishes inboard reverse gear if desired. This gear has one clutch and one brake band on the outside of the drum. When both these are loose the engine can run freely. By moving the lever forward the engine is clutched direct to the propeller shaft which drives the propeller wheel in a direction to move the boat forward. When it is desired to move the boat backwards the lever is pulled back, engaging the brake band on the outside of the drum, holding the drum stationary, and by the aid of spur gears on the inside of the drum the propeller shaft is reversed. The company's four-cycle engines are manufactured in sizes of 15 horsepower or larger. This company now furnishes launches in all sizes from 16 feet up.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS.

314 Madison Avenue, New York City.

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Newman's improved portable watchman's clock is illustrated and described in a circular distributed by the Newman Clock Company, Masonic Temple, Chicago, Ill. The various special features of the clock are fully explained in the circular.

Ice-making and refrigerating machinery apparatus are described in a catalogue issued by the Featherstone Foundry and Machine Company, 348 North Halsted street, Chicago, Ill. The machines manufactured by this company have been on the market for twenty-five years, and among the advantages claimed are simplicity of design, economy of operation, and durability.

Gasoline, electric, and steam launches, sailboats, rowboats, canoes, hunting, and fishing boats, are described in the handsomely illustrated 1905 catalogue issued by the Madison Boat Company, Madison, Wis. The catalogue states that this company's factory covers 8,500 square feet of floor space, and that it is equipped with the latest types of modern machinery. The catalogue will be forwarded upon the receipt of six cents for postage.

"Main Steam Pipes," by W. H. Wakeman, is the title of the leading article in the May number of *Graphite,* issued by the Joseph Dixon Crucible Company, Jersey City, N. J. In the same issue with this publication is described the advantages of Dixon's Ticonderoga flake graphite in the lubrication of the bearings of engines and machinery. Among the advantages claimed are the following: Seizing or cutting of metal surfaces is impossible in the presence of a layer of flake graphite which, being renewed from time to time, takes up all wear and prevents abrasion of the parts; graphite smooths and polishes the surfaces thereby reducing friction to a minimum; if graphite is used in connection with an oily lubricant thinner and cheaper oils are sufficient to assure good results and much less oil is required than if no graphite were used.

The Bird-Archer marine boiler compound is the subject of a booklet issued by the Bird-Archer Company, 574 West Broadway, New York city. The booklet states that this compound reduces coal consumption, increases steaming capacity of boilers, thereby increasing the revolutions of the engine; prevents pitting and corrosion, thus reducing the cost of maintenance. The company states that its boiler compound removes oil, grease, and scale; that it is absolutely uninjurious to steel, iron, and packing; that it does away with the necessity of using zinc in boilers, and that it will not cause boilers to foam. Among the users of this company's marine boiler compound, so the booklet states, are the Pennsylvania Railroad Company, the Erie Railroad Company, the New York, New Haven and Hartford Railroad Company, the United States Army transport service, and many others. This booklet contains a large number of testimonials regarding the company's compound from well-known steamship companies and engineers.

The forged-steel flanges manufactured by the American Forged Steel Company, 64 Wabash avenue, Chicago, Ill., are the subject of a folder this company is distributing. Forged-steel flanges, so the folder states, render high-pressure connections absolutely safe. By their use joints are easily made and remain perfectly tight. This company's flanges are forged weldless from open-hearth steel, and by a special process there is forged an extra heavy hub on the flanges. The outside of the flanges is beveled for caulking.

"The Navigator or Mariner's Guide," second edition, published by Harry Louderbrough, proprietor of the New Jersey Paint Works, Jersey City, N. J., is just off the press. This work, which contains 202 pages, is designed as a handy reference for the use of navigators, yachtsmen, and students of navigation. It explains how to find latitude and longitude by observation, and contains many other useful calculations and tables by Captain R. M. Pugsley. There is also a pocket containing charts of New York bay and harbor, Long Island Sound, Boston, Gloucester, and Portland harbors, Delaware and Chespeake Bays, Block Island to Currituck, and a current-course projector. The book is profusely illustrated, among other illustrations showing the flags and pennants of the international code, half-tone illustrations, and many well-known racing yachts and other vessels, sail and steam. Among the subjects on which information is furnished are fog-signal devices, tables for correcting soundings, signals to the engine room, loading tables, speed and revolutions, fouling and marine painting, the law of storms, the use of the barometer, explanation of astronomical signs, Mercator and mile latitude, sailings by computation, latitude by chronometer, latitude by sunset and sunrise, explanation of compass terms, latitude by meridian, explanation of the use of the sextant and octant, tables of weights, finding the distance of any fixed object, yachting rules, statement giving the tonnage of the world's merchant marine, pilot rules, signalling by various codes, calendar for every year from 1801 to 2003, and a vast deal of other information.

Radial drills, vertical boring and turning mills, multiple spindle drills, both upright and horizontal, are described in an illustrated folder issued by the Bausch Machine Tool Company, Springfield, Mass.

The "Minimax" fire extinguisher is described in a folder issued by the "Minimax" Company, 24 East Twenty-first street, New York city. The folder states that for this device there is required no hose or mechanism, and no turning up side down, that it is instantaneous, automatic, economical, efficient, and that there is no evaporation.

The Pacific Mail Steamship Company has issued from its Eastern office, 349 Broadway, New York city, a handsomely illustrated folder which gives interesting information concerning travel to the Orient and around the world. Special attention is called to the company's fleet operated from San Francisco, and touching Honolulu, Yokohama, Nagasaki, Shanghai, Hong Kong, and Manila.

Polishes—liquid, paste, and powder—for brass, copper, nickel, and other metals, are described in a catalogue issued by the Royal Lubricating Oil Company, 116 Broad street, New York city. This catalogue states that the Royal polishes are used in the United States navy yards and life-saving stations, as well as by a large number of steamship companies.

Multiple sight-feed oilers, with signal lever reservoir outfits, manufactured by the William Powell Company, Cincinnati, O., are described in a leaflet distributed by this company which states that when it is desirable to oil a number of bearings from one reservoir the Powell multiple oiler is a convenient and economical arrangement, besides being a great saving in the labor of filling, as there is only one reservoir to attend to.

"Sea Togs" is the title of a booklet issued by John C. Hopkins & Company, 119 Chambers street, New York city. The introduction states: "for many years the house of Hopkins has stood for all that is correct in marine hardware, yacht supplies, and yacht clothing. In addition, it has enjoyed an inevitable reputation for the boats, canoes, sales, tents, awnings, and fishermen's supplies with which its name is associated."

Punching and shearing machines are described and illustrated in a catalogue issued by Henry Pels & Company, 68 Broad street, New York city. Regarding its John's "Patent Combined Universal Horizontal and Vertical Punch," the catalogue states that this machine is especially built for boiler shops and shipyards, in any size and depth of throat. The catalogue states that the John's shearing machines shear plates, flat, round, and square bars, tees and angles, and cut angles on a bevel. Their simplicity of construction allows a quick changing of tools.

Cranes and electric travelers are the subjects of Catalogue No. 36, issued by the Whiting Foundry Equipment Company, Harvey, Ill. This catalogue states that the introduction of the traveling crane has revolutionized methods of manufacture and the entire theory of shop designing. Material of any kind may be quickly transported from one place in the shop to any other, or finished machinery may be handled in the most delicate manner when required, without labor and without interference with work on the floor. Electric traveling cranes, so the catalogue states, are the highest development of crane designing. Clutches and intricate parts are avoided. Gearing and other wearing parts are reduced to a minimum and efficiency correspondingly increased.

The drill grinders manufactured by the Washburn Shops, Worcester, Mass., are described in illustrated Catalogue "C" now being distributed.

The Willamette Boiler Works, Portland, Ore., manufacturer of marine and stationary boilers, is distributing a neat calendar printed on an almuinum card.

The steam engines built by the Corliss Engine Works, 4041 North Fifth street, Philadelphia, Pa., are the subject of an illustrated catalogue this company is mailing.

"The Blue Book of Air Compressors" is published by the Ingersoll-Sergeant Drill Company, 26 Cortlandt street, New York city. This booklet illustrates and describes the various types of air compressors and pneumatic tools manufactured by this company.

Punching machines, steam hammers, flanging clamps, wire rope, sheaves, derrick fittings, general forgings, and machine tools, are described and illustrated in Catalogue C, published by the Cockburn Barrow and Machine Company, Jersey City, N. J.

The National Association of Manufacturers, 170 Broadway, New York city, is mailing a pamphlet entitled "Just a Word," which contains illustrations and descriptions of the offices of the Association.

Portable electrical drills and electric grinders are described and illustrated in a folder issued by the Cincinnati Electrical Tool Company, Cincinnati, O. This company will send its machines on trial if desired.

Catalogue of steamboat work.—A supplementary catalogue has been issued by Marine Iron Works, Station A, Chicago, Ill., which will be sent free on request. It contains illustrated descriptive matter pertaining to some of this company's latest steamboat work.

Nickel steel for fire boxes, boiler plates, rivets, forgings, castings, and other uses, are briefly referred to in a folder issued by the International Nickel Company, 43 Exchange Place, New York city. The subject is one which will be of much interest to users of these specialties.

The Crosby Steam Gauge and Valve Company, Boston, Mass., will send a folder describing the Crosby spring-seat globe and angle valves to anyone desiring the same.

Engines and air compressors.—We are in receipt of a catalogue from the St. Louis Steam Engine Company, St. Louis, Mo., describing the Star vertical self-contained engines and air compressors.

The Heine Safety Boiler Company, St. Louis, Mo., is issuing a catalogue describing the Heine water-tube boiler. These boilers are made for all pressures, duties, and fuels.

Wickes Brothers, 113 Cedar street, New York city, are mailing a monthly stock list of new and second-hand boilers, engines, pumps, generators, and other power equipment and iron-working machinery. Anyone mentioning MARINE ENGINEERING can secure these lists.

Every boiler maker, shipbuilder, manager of a dry-dock, foreman of a forge shop, and any other man who has to do with engineering work should send for a free copy of a 16-page catalogue printed in two colors, issued by the Wells Light Manufacturing Company, 44 Washington street, New York, illustrating and describing the Wells light.

Vertical automatic engines are described in Bulletin No. 103, issued by the Quincy Engine Works, Quincy, Ill. This company makes horizontal heavy-duty Corliss engines, vertical engines, motor-driven power pumps, open feed-water heaters, heavy sheaves and band wheels, and special machinery.

"Wouldn't a little wharf be handy right down in front of your summer cottage?" is asked by the Edson Manufacturing Company, 255 Atlantic street, Boston, Mass. The company states in literature it is distributing that one of its hydraulic pile sinkers will build such a wharf at a very small cost, and asks readers to send for its guarantee trial offer.

Marine gasoline engines.—Hall Brothers Gas Engine Works, Philadelphia, Pa., is distributing a catalogue describing and illustrating its marine gasoline engines. The company's aim in designing its engines has been to build machines which will stand the hard usage that engines are subjected to in the hands of the average person. By altering the compression of the Hall engines they may be adapted to the use of alcohol and kerosene.

"Plants and Types" is the subject of an illustrated 32-page catalogue published by the National Electric Company, Milwaukee, Wis. This catalogue is illustrated by numerous halftone engravings and printed on heavy covered paper. It is especially handsome typographically. The preface states that the object of the publication is to give a general idea of the company's electrical product. The company's bulletins deal with the details of construction, and will be forwarded upon request.

Milling machines and other machine tools are described and illustrated in a 24-page catalogue issued by the Garvin Machine Company, Spring and Varick streets, New York city.

Small belted machines is the subject of Bulletin No. 51, issued by the Crocker-Wheeler Company, manufacturers and electrical engineers, Ampere, N. J.

Re-grinding valves, manufactured by Lunkenheimer Company, Cincinnati, O., are described in a folder this company is issuing. The folder states: "Proof of superiority is found in their adoption as standard by the United States Navy. They are extensively used on all sorts of steam craft."

The pneumatic flue welder and scarfer is illustrated in a circular which will be sent to inquirers by the Draper Manufacturing Company, Port Huron, Mich. This device is one which will appeal to every one of our readers who has to do with the use of boiler tubes, etc.

"The Motor that Motes," and about 100 testimonials from satisfied purchasers, are the subject of a bulletin issued by the Bridgeport Motor Company, Bridgeport, Conn. This company is also distributing a 30-page catalogue which describes and illustrates gasoline motors and launches.

"Eighty-nine vessels have been equipped with our engines and boilers," is the claim made by the Portland Company, Portland, Me., in a folder the company is issuing. This company has patterns of more than forty sizes of single-, compound-, and triple-expansion marine engines from 10 to 1,800 horsepower.

Pneumatic tools and appliances are described in an illustrated folder sent out by the Aurora Automatic Machinery Company, Aurora, Ill. Regarding the company's reversible drills the statement is made that they can be reversed at full speed, a twist of the wrist stopping, starting, or reversing them.

A new yacht gun.—The Hall yacht signal and saluting guns manufactured by the Naval Electric Company, 95 Liberty street, city, are described in an illustrated catalogue this company is distributing. The catalogue states that many well-known yachts have been equipped with this company's guns, among them being the *Kanawa, Hauoli, Nourmahal,* and many others.

"Telephone Annunciator Practice," a few examples of representative installations, is the title of a pamphlet issued by the Electric Gas Lighting Company, 115 Purchase street, Boston, Mass. This company's telephone system is applicable to marine use, and has been installed on the *Dakota* and *Minnesota,* belonging to the Great Northern Steamship Company.

Industrial railways are described in Pamphlet No. 051, published by the C. W. Hunt Company, West New Brighton, Staten Island, N. Y. The main feature of this company's system of industrial railways is stated to be its flexibility—the cars running round curves of a radius of 12 feet as easily as they run on a straight track.

"A Modern Industrial Plant" is the title of Bulletin No. 175, issued by Dodge & Day, consulting engineers, Nicetown, Philadelphia, Pa. The bulletin states that Dodge & Day have made a study of economics as applied to manufacturing establishments, and that the engineering work of their mechanical, architectural, and electrical departments assures harmony of buildings and equipments.

"Cosmos" anti-friction metal is described in a folder mailed by Le Grand O. Robson, 1234 Broadway, Buffalo, N. Y. The claim is made that this metal is not subject to oxidization, that it is durable, double refined, free running, that it makes clean castings, that its quality never varies, and that it is in general use throughout the United States. The folder states: "I guarantee that if Robson's 'Cosmos' anti-friction metal is not satisfactory you may in thirty days after shipment return at my expense all that is unused and I will refund your money."

Composition yoke riveters for boiler, tank, shipbuilding and other structural iron and steel construction, are described in Catalogue No. 3, issued by the Hanna Engineering Works, 820 Ellston avenue, Chicago. In the movement of this riveter the company states that it has combined in a simple form, toggles, levers, and guide links to give the large opening of the toggle joint movement with its gradually increasing pressure until the desired pressure is reached. Then a simple lever movement through a considerable space under uniform maximum pressure.

"Poldi" tool steel is described in a catalogue issued by Peter A. Frasse & Company, 92 Fulton street, New York city, importers of tool steel in bars, rods, sheets, cold rolled strips, wire, drill rods, and boiler makers', machinists' and manufacturers' supplies of all kinds. Regarding the "Poldi extra special very hard steel," the catalogue states that this steel is intended for all kinds of cutting tools not subjected to blows or severe shocks where a very fine edge is desired, capable of wearing for a long time. Directions are given for cutting, forging, and hardening the steel.

Condensing machinery is the subject of a 60-page illustrated catalogue issued by Dean Brothers' Steam Pump Works, Indianapolis, Ind.

Dewhurst slag ladles and cars are described in an illustrated catalogue mailed by the Wellman-Seaver-Morgan Company, Cleveland, O.

Inter-pole variable speed-motors are the subject of Circulars Nos. 2 and 3, Series B., issued by the Electro Dynamic Company, Bayonne, N. J.

"A Short Story of Charles Babbage" is issued in pamphlet form by Wyman & Gordon, manufacturers of drop forgings, Worcester, Mass., and will be sent free upon application.

Burrows' patent lock-nut is illustrated and fully described in a 6-page folder being distributed by the American Lock Nut Company, 134 Congress street, Boston.

Watertown automatic engines are described and illustrated in a catalogue issued by the Watertown Steam Engine Company, Watertown, N. Y.

Gate valves for steam and water, bent pipe work, tools and supplies of all kinds for steam, water, and gas users are described in circulars distributed by the Walworth Manufacturing Company, 132 Federal street, Boston, Mass.

Cork life preservers and ring buoys are illustrated and described in a booklet issued by the Armstrong Cork Company, Pittsburg, Pa. These life preservers, the booklet states, are made in one piece. They contain no pegs, pins, or glue—they are all cork.

"Pipe and Boiler Coverings and their Uses" is the title of an illustrated booklet issued by the H. W. Johns-Manville Company, 100 William street, New York city. Engineers interested in the subject should send for a free copy of this booklet.

Fan outfits are the subject of Circular No. 53, issued by the Rochester Electric Motor Company, Rochester, N. Y. These fans are designed to remove gases, steam, dust, heat, smoke, and also for ventilating and distributing cold or hot air, and for drying purposes.

Blow-off, three-, and four-way valves, self-locking, straightway, and other types of valves are illustrated and described in a neat pocket-sized catalogue distributed by the Homestead Valve Manufacturing Company, Pittsburg, Pa. Copies can be had free upon application by referring to this paper.

Electric fans are the subject of Bulletin No. 309, issued by the Sprague Electric Company, 527 West Thirty-fourth street, New York city. This bulletin states that there are two ways of keeping cool. The first is to keep away from the heat and the other is to keep the heat away from you. The second problem the bulletin claims to solve.

Waterproof marine glue, manufactured by Siemon & Elting, 194 Front street, New York city, is the subject of a folder which this company is distributing. The folder claims for this glue that it will not crack over the deck, that it will not melt nor become sticky in tropical heat, that it will not oxidize or rot, and that extreme cold has no effect upon it.

"The National Electrical Catechism," published by the National Electric Company, Milwaukee, Wis., will be issued as a serial, and by presenting it in the form of questions and answers, will give in a condensed way much information concerning the application of direct and alternating currents, taken from the most up-to-date experience. This catechism is designed not only for the layman but for the practical engineer, and will be forwarded free upon request.

Allen boiler riveters.—John F. Allen, 320 Girard avenue, New York city, recently received the following letter from the Thompson Iron Works, Philadelphia, Pa.: "Mr. John F. Allen, New York City. Dear Sir—Replying to your favor asking us regarding the 72-inch reach 'Allen Boiler Riveter,' would say that same are working satisfactorily and are undoubtedly superior to any riveters we have ever used. We can especially recommend them for uniform and thoroughly light work. W. W. Posey, superintendent."

Water-power equipment is the subject of a catalogue issued by the Wellman-Seaver-Morgan Company, Cleveland, O. Among this company's products are steel works, rolling mills, traveling cranes, gas engines, coal-handling machinery, hoisting machinery, and steel castings.

An improved water-tube cleaner.—The "Demon" water-tube cleaner, made by the General Specialty Company, 101 Seneca street, Buffalo, N. Y., is described in a folder issued by this company. This is a rotary machine and the cutters, which are self-sharpening, are forced out by powerful springs. Their action on the scale is neither of a chopping nor grinding nature, but is that of a direct cutting tool. The outward movement of the cutters is limited by adjustable stops, thus preventing injury to the tube, and relieving the cutters of excessive wear. The cutting tool is mounted on the shaft of the motor and the latter is properly centered in the tube by three centering lugs which insure uniform work on all sides of the tube.

BUSINESS NOTES.

ALLEN RIVETING MACHINES.—John F. Allen, 370 Gerard avenue, New York city, reports a large demand for his riveting machines, which, he says, many of the largest concerns throughout the country are using.

REMOVAL NOTICE.—The New York office of the Ashton Valve Company, 271 Franklin street, Boston, Mass., manufacturer of pop safety valves and pressure and vacuum gauges, has been removed from 110 Liberty street to 128 Liberty street.

THE JEFFERSON UNION COMPANY, Lexington, Mass., announces that it has purchased the business of making and selling the famous Jefferson Union flange, formerly conducted by the Jefferson Manufacturing Company. With added improvements and facilities, that its orders may be filled promptly, this company starts with a bright future.

REMOVAL NOTICE.—The executive offices of the American Steel Foundries have been removed from 72 Broadway and now occupy the entire eleventh floor of 42 Broadway, New York city.

MR. J. W. DUNTLEY, president of the Chicago Pneumatic Tool Company, Chicago, Ill., is in Europe on business. The Chicago Pneumatic Tool Company reports that its business shows a heavy increase in all lines, and that its foreign trade is showing encouraging progress.

FALLS HOLLOW STAYBOLT IRON IN AUSTRALIA AND CUBA.—The Falls Hollow Staybolt Company, Cuyahoga Falls, O., announces that it has received large orders for its hollow staybolt iron from Cuba and from the government of West Australia, for use on railroads.

FREE LEATHER CARD CASE AND POCKET BOOK.—The Electric Controller and Supply Company, Cleveland, O., is distributing a neat leather pocket book and card case containing a small memorandum book. We understand the company will send this handsome article free to readers mentioning MARINE ENGINEERING.

DAYTON PNEUMATIC TOOLS.—The Dayton Pneumatic Tool Company, Dayton, O., manufacturer of air compressors and machinery supplies, reports that its tools have been adopted by one of the largest shipbuilding concerns in America, which after making a thorough test has within sixty days placed orders for more than fifty "Green" pneumatic hammers.

FREE SAMPLE OF METALLIC FILLER.—D. N. Clark, Shelton, Conn., will send a free sample package of his metallic filler to any reader of MARINE ENGINEERING. This filler is made especially for blowholes, cracks, and uneven spots in castings, and, Mr. Clark states, will make the castings look as if there had been no unevenness or spots whatever.

THE NEW YORK GEAR WORKS, 56 Greenpoint avenue, Brooklyn, N. Y., manufacturers of the ball improved transmission and reverse gears for motor boats and automobiles, report that they are running their factory at full capacity in order to meet the steadily increasing demand for their product. They also state that more than one hundred engine builders are now using their reverse gears. Catalogue will be sent free upon application.

EDWARD KENDALL & SONS, Cambridge, Mass., have sold their boiler plant, rights, etc., to Robert Mumford Boiler Manufacturing Company. The plant will be removed to Framingham, Mass., where a large plant is being built. The main shop is a concrete and steel building, 300 by 150 feet. The offices occupy a building 40 by 40 feet. The new plant will be ready for occupancy in the near future. It is expected that all the late employees of Edward Kendall & Sons will go with the new concern.

NEW DETENT MOTION for the American-Thompson improved indicator.—The American Steam Gauge and Valve Manufacturing Company, 208 Camden street, Boston, Mass., manufacturer of the American-Thompson indicator, states that the greatest improvement ever added to the steam engine indicator is the new improved detent motion which this company uses. This attachment, so the company states, makes the indicator particularly adapted to high-speed marine and stationary steam engines and gasoline engines. With this attachment it is possible to connect the indicator to high-speed reducing motions and stop the drum of the indicator without unhooking the card or stopping the engine.

Removal notice.—The Stirling Company, manufacturer of the Stirling-Niclausse water-tube boilers, has removed its executive offices to the new Trinity Building, 111 Broadway, New York city.

The Albany grease trade-mark (see advertising page 17).—The value of a trade-mark depends upon its character and the quality of the goods back of it. That of Adam Cook's Sons, 313 West street, New York city, makers of Albany grease, has an individuality which has served to fasten the lubricant it advertises upon the memory of all having to do with the smooth and safe running of machinery, say the makers of this lubricant. "The trade-mark forms a link between the manufacturer and the consumer, guaranteeing the consumer that the goods bearing such mark are made by the same manufacturer as the goods which he previously purchased under the same mark." The trade-mark is therefore a guarantee of quality, and when the quality is of the highest, the importance of the trade-mark is far-reaching and its consideration a matter of interest. The manufacturers state that there is scarcely an engineer who does not know Albany grease and its familiar trade-mark. The mark was first used in 1868, and was designed under the instructions of Mr. Adam Cook, the original owner of Adam Cook's Sons. The letters "O-EZR-IC" have been the cause of much speculation. They signify "Nothing easier I see" than to slide down the plank smoothly and without friction when Albany lubricating compound is applied. During the thirty-seven years that Albany grease has been before the public this trade-mark has been used by the manufacturers on all their business stationary and on all advertisements. Adam Cook's Sons state that they guarantee Albany grease will save from one-half to three-quarters of the cost of lubricating by oils, and that they have on file thousands of testimonial letters received. An Albany grease cup and a sample of Albany grease to test will be sent free to all who mention Marine Engineering.

MARINE ENGINEERING EMPLOYMENT BUREAU

Full information regarding the purposes of this Bureau, together with instructions regarding registration, etc., furnished upon application to Marine Engineering Employment Bureau, 17 Battery Place, New York city.

All correspondence, concerning either vacancies or situations wanted, is strictly confidential.

MEN SEEKING POSITIONS

We have applications registered for positions as follows, and the references of each applicant have been carefully investigated:

ASSISTANT OR SUPERINTENDING ENGINEER to shipping concern or factory seeks position; is 30 years old, married, and has had several years experience at sea as chief engineer. Application No. 100.

BOILER-MAKER FOREMAN seeks position. Is at present foreman of railroad shops and has charge of nearly one hundred men; has had twelve years' experience as foreman; posted in the latest boiler practice; has best references as to ability and character; is 38 years old. Application No. 73.

BOILER-SHOP FOREMAN. Age 35; single; many years' experience in Navy Yard and leading shipyards. Application No. 59.

BOILER-SHOP FOREMAN. Age 37; single; 16 years' experience in boiler-shop work. Application No. 47.

CHIEF OR ASSISTANT CHIEF DRAFTSMAN—ENGINE. Age 33; married; has had sea experience and thirteen years as leading and chief draftsman of private and government shipyards. Application No. 25.

CHIEF DRAFTSMAN OR SUPERINTENDING ENGINEER seeks position. Has had extensive experience in several of the best known shipyards, and can furnish the best of references. Application No. 81.

CHIEF DRAFTSMAN OR CHECKER seeks position; is 36 years old; married; was with the Carnegie Steel Company for about three years; later with the National Steel Company, and with the American Bridge Company. Application No. 79.

DESIGNER, EXPERIENCED, of dredges and other types of vessels, seeks position; is 28 years old; has had 10 years of experience in Great Britain and this country in leading shipyards. Application No. 82.

DESIGNER AND DRAFTSMAN. Has had many years' experience in launch and river boat work. Designed some of the fastest river boats in the country. Application No. 61.

DRAFTSMAN. Position in a drafting office desired by a young man just finishing his course in naval architecture. Application No. 108.

DRAFTSMAN, ENGINE AND BOILER. Age 30; unmarried; has Danish marine license; technical school graduate. Application No. 57.

DRAFTSMAN—HULL. Age 20; single; experienced in architectural work, but prefers marine drafting. Application No. 51.

DRAFTSMAN—HULL, OR INSPECTOR. Age 37; married; had experience both in government yards and private yards. Application No. 30.

DRAFTSMAN—HULL. Age 22; single; born in Norway; studied Technical schools in Norway and Germany; experience as draftsman, also as shipfitter. Application No. 31.

DRAFTSMAN—HULL AND ENGINE. Age 26; single; graduated Webb Academy; has had four years' experience in navy yard work; desires connection with private shipyard. Application No. 41.

DRAFTSMAN—ENGINE, STEAM OR GAS. Forty-three years old; single; born in Germany; has had extensive experience in designing and drafting; has had sea experience. Application No. 32.

DRAFTSMAN—MARINE. Age 34; married; accustomed to intricate drafting work. Application No. 50.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

12 West 31st Street, New York.

President, FRANCIS T. BOWLES.
Secretary-Treasurer, W. J. BAXTER.
Executive Committee, LEWIS NIXON, EDWIN A. STEVENS, HARRINGTON PUTNAM, STEVENSON TAYLOR. *Ex-officio,* FRANCIS T. BOWLES, W. J. BAXTER.

AMERICAN SOCIETY OF NAVAL ENGINEERS.

Navy Department, Washington, D. C.

President, Commander A. F. DIXON, U.S.N.
Secretary-Treasurer, Lieutenant CHARLES K. MALLORY, U.S.N. (retired.)
Council, Captain GEORGE W. BAIRD, U.S.N.; Commander J. K. BARTON, U.S.N.; Commander W. M. PARKS, U.S.N.

MARINE ENGINEERS' BENEFICIAL ASSOCIATION.

National President, FRANK A. JONES, 1959 Eddy St., San Francisco, Cal.
Vice-President, CHARLES W. ROBINSON, 908 G. St., N. W., Washington, D. C.
Second Vice-President, EVANS I. JENKINS, 153 Clinton St., Cleveland, Ohio.
Secretary, GEORGE A. GRUBB, 1318 Wolfram St., Lake View, Chicago.
Treasurer, ALBERT L. JONES, 289 Champlain St., Detroit, Mich.
Advisory Board, WILLIAM F. YATES, 120 Liberty St., New York city; GEORGE F. KEATING, 74 Webster St., East Boston, Mass.; W. D. BLAICHER, 10 Exchange St., Buffalo, N. Y.

ADDRESSES OF CORRESPONDING SECRETARIES.

No. 1, W. D. Blaicher, 10 Exchange St., Buffalo, N. Y.
" 2, Wm. Kelly, 11 Wall St., Cleveland, O.
" 3, A. L. Jones, 289 Champlain St., Detroit, Mich.
" 4, James A. Macauley, 5802 Indiana Ave., Chicago, Ill.
" 5, Otto Boettger, 1035 E. Hopkins Ave., Baltimore, Md.
" 6, Wm. Arste, 322 Pine St., St. Louis, Mo.
" 7, Wm. T. McElwee, Box 1556, Portland, Me.
" 9, Wm. Bridges, 784 1-2 12th St., Milwaukee, Wis.
" 13, John G. Paulding, 1746 Tulip St., Philadelphia, Pa.
" 14, Joseph F. Dumas, 403 Dauphin St., Mobile, Ala.
" 15, R. L. Skinner, 622 Louisa St., New Orleans, La.
" 17, Jas. D. Robinson, 6th and Columbia Sts., Newport, Ky.
" 18, Wm. Hurst, 715 Walnut St., Cairo, Ill.
" 20, Jos. B. Barry, 206 Keel St., Memphis, Tenn.
" 21, J. H. Foley, 206 N. Mulberry St., Vicksburg, Miss.
" 23, Wm. R. Lewis, 213 E. Front St., Jeffersonville, Ind.
" 24, Hugh L. Edwards, 511 Washington St., Paducah, Ky.
" 26, T. H. Kirkbridge, 228 Bond St., Evansville, Ind.
" 27, L. C. Schwall, 598 S. Madison St., Bay City, Mich.
" 29, James R. Sutherland, Charleston, W. Va.
" 30, E. R. Humphrey, 21 State St., Pittsburg, Pa.
" 33, James J. Waters, 21-24 State St., New York, N. Y.
" 35, William M. Coombs, 36 East St., San Francisco, Cal.
" 36, Jos. Thomas, 57 Sea St., New Haven, Conn.
" 37, John B. Bender, 1215 Evesham Ave., Toledo, Ohio.
" 38, C. H. Wolford, 73 Starr Boyd Bldg., Seattle, Wash.
" 39, Frank Feeney, 460 E. 12th St., Erie, Pa.
" 40, Chas. Drouet, 1003 Ave. I, Galveston, Tex.
" 41, W. H. Marshall, 343 Holladay St., Portland, Ore.
" 42, Jas. Manning, 802 E. Duval St., Jacksonville, Fla.
" 43, A. J. Wilson, 1327 La Peer Ave., Port Huron, Mich.
" 44, Chas. J. Sullivan, 480 1st St., Manistee, Mich.
" 45, W. L. Salter, care O. S. S. Co., Savannah, Ga.
" 46, D. W. Farrell, Clayton, N. Y.
" 47, J. R. Cook, Sault Ste. Marie, Mich.
" 48, Alfred Hegemer, 140 E. Park St., Sandusky, O.
" 51, H. S. Connell, 12 Ranson St., Muskegon, Mich.
" 53, Harry Stone, Box 445, Marine City, Mich.
" 55, Archie Stalker, Box 883, Cheboygan, Mich.
" 57, E. B. Meeker, 71 Abeel St., Kingston, N. Y.
" 58, E. Capers Haselden, Box 31, Georgetown, S. C.
" 59, George F. Keating, 74 Webster St., E. Boston, Mass.
" 62, N. S. Lawrence, 30 Connecticut Ave., New London, Conn.
" 63, M. J. Burke, 152 Sheridan Ave., Albany, N. Y.
" 65, W. C. Palmer, care Consumers' Coal Co., Charleston, S. C.
" 67, James K. Dole, Saugatuck, Mich.
" 70, Charles T. Smith, 665 Commercial St., Astoria, Ore.
" 72, Wm. T. Findlay, 130 W. Bridge St., Oswego, N. Y.
" 73, E. M. Donahue, 1308 Cherry St., Green Bay, Wis.
" 75, Wm. D. Hemenway, Alexandria Bay, N. Y.
" 76, Orson Vanderhoef, Grand Haven, Mich.
" 77, John P. Hall, 1215 Huron St., Manitowac, Wis.
" 78, J. P. Burg, 2722 Minnesota Ave., Duluth, Minn.
" 80, Edward S. Welch, 338 Hamilton St., Albany, N. Y.
" 81, Jas. L. Sweeney, 206 E. Sarragosa St., Pensacola, Fla.
" 82, Fred H. Gowell, 427 Middle St., Bath, Me.
" 85, John A. Packard, 623 Merchant St., Alpena, Mich.
" 86, Sherman A. Smith, 737 Menekaunee Ave., Marinetta, Wis.
" 87, George B. Milne, 809 Fourth St., Detroit, Mich.
" 88, C. O. Chapman, S. B. Canal, Sturgeon Bay, Wis.
" 89, Geo. E. Willard, 4 Isabella St., Ogdensburg, N. Y.
" 91, A. L. McLaren, 130 W. Walnut St., Ashtabula, O.
" 92, Jos. D. Budd, Box 50, Sta. I, Saginaw, W. S., Mich.
" 93, W. J. Cook, 2220 G. St., N. W., Washington, D. C.
" 94, George R. Jones, Box 222, Washington, N. C.
" 95, P. J. McMahon, Box 199, Key West, Fla.
" 98, C. N. Vosburg, 6323 Patton St., New Orleans, La.
" 100, H. F. Mocine, Honolulu, H. I.
" 101, J. K. Cotton, Box 765, Norfolk, Va.
" 102, Fred. W. Linsemeyer, 210 Clinton St., South Haven, Mich.
" 103, A. E. Pittman, Box 378, New Bern, N. C.

TRADE PUBLICATIONS.

"Notes on Induction, Integrating Wattmeters and their Use," by A. A. Serva, a paper read recently before the meeting of the Colorado Electric Light, Power and Railway Association, is printed in pamphlet form and distributed with the compliments of the Fort Wayne Electric Works, Fort Wayne, Ind.

Albany grease calendar.—Adam Cook's Sons, 313 West street, New York city, are distributing a neat calendar calling attention to Albany grease. The calendar states that to any engineer sending the meaning of the letters "OEZRIC," appearing in the Albany grease trade-mark, the company will send free of charge a grease cut and a sample of its grease. This grease, the calendar states, is adapted to the use of all marine engines and for dynamos, general electrical, and high-speed machinery.

The Bullard automatic wrench is described and illustrated in a booklet issued by the Bullard Automatic Wrench Company, Providence, R. I. The catalogue states that this is the only wrench which will turn pipe lying on a flat surface; that this wrench has the standard range, and that it will outwear three wrenches of any other make. The strain on the jaws is distributed by use on different sizes of pipes thereby increasing the durability of the wrench. Its construction is such as to admit of immediate and positive adjustment to any size within its range. It eliminates the necessity of using nuts or screws in adjustment and requires the use of but one hand, giving the operator free use of the other. It locks and unlocks instantly without cramping or wedging pipe, and the jaws are always in alignment. It is manufactured of drop forged steel and the jaws are made of high-grade tool steel.

New machinists' tools are described and illustrated in a pamphlet issued by the Brown & Sharpe Manufacturing Company, Providence, R. I. Among the tools described are micrometers; caliper sets, which it is stated are inexpensive but accurate and trustworthy reference tools for inspecting the finished product, as well as for general shop use; improved steel beam trammels, "Universal" dividers, a scriber point holder, which has a fine and quick adjustment obtained by a screw enclosed in the beam which engages the knot on the scriber point holders. By pulling up the small knurled knob at the top of the post, the screw is released and the post can be quickly adjusted, the knob springing into place as soon as released; single and double-point scribers; "Tool Makers'" knife-edge straight edges, made for work requiring extreme accuracy. These are made from the best quality of tool steel and are highly finished, the working edges being hardened and carefully lapped after grinding.

Franklin compressors (new patent, type G), manufactured by the Chicago Pneumatic Tool Company, Fisher Building, Chicago, Ill., are described in an illustrated 30-page catalogue which this company is distributing. The catalogue states that these compressors, when first introduced about four years ago, attracted attention because of their sound design, massive proportions, and the exceptionally high engineering plane upon which their lines are based. The new type described in this catalogue is designed to meet the demand for simple, efficient, compact, and moderate-priced compressors representing the latest development in this class of machine. The frame is of box-section design with a large factor of safety to withstand the strains when working at maximum load. Great importance is attached by the company to the feature of accessibility, as should the valves cease to perform their proper functions the compressor is either wholly or partially disabled until the trouble is remedied; hence the desirability of immediately accessible valves. Another point that the company calls attention to is the fact that the valve seat is a part entirely separate from the cylinder proper and may be removed, replaced, or renewed whenever occasion requires. Every compressor undergoes before shipment a thorough working test. All steam and air cylinders have indicator connections, and indicator diagrams are taken under exact working conditions; and finally a capacity test determines the capacity of the compressor in actual volume of compressed air delivered.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS.

314 Madison Avenue, New York City.

President, JOHN J. AMORY.
First Vice-President, H. A. LOZIER, JR.
Second Vice-President, CHARLES A. STRELINGER.
Third Vice-President, HENRY R. SUTPHEN.
Treasurer, J. S. BUNTING.
Secretary, HUGH S. GAMBEL.
Executive Committee, JOHN J. AMORY, Chairman: 1908, J. B. SMALLEY, JAMES CRAIG, JR., C. L. SNYDER, EUGENE A. RIOTTE, A. MASSENAT. 1907, JOHN J. AMORY, H. A. LOZIER, JR., J. S. BUNTING, H. N. WHITTELSEY, CHARLES A. STRELINGER. 1906, S. J. MATTHEWS, A. SNYDER, H. H. BRAUTIGAM, ALBERT E. ELDRIDGE, HENRY R. SUTPHEN.

A satisfactory punching machine.—The Cochran Barrow and Machine Company, Jersey City, N. J., has received the following letter from G. L. Stuebner Iron Works, Long Island City, N. Y.: "We have used for more than twenty years punching machines of the quick-acting type built by your firm, and the fact that we recently ordered three more machines from you indicates that we consider yours to be the most rapid and the best-built machines for the purpose for which they are intended."

Direct-current generators are described and illustrated in Bulletin No. 46, issued by the Northern Electrical Manufacturing Company, Madison, Wis. This catalogue states: "The unique feature of Northern literature is that in almost every case the apparatus illustrated represents machinery purchased by some one to do something better or cheaper than has been accomplished before." Illustrations are given of a number of Northern generators and their parts, and also of many well-known power houses where these generators are in use.

"Advertising for Profit" is the title of a pamphlet issued by the Manufacturers' Advertising Bureau, 126 Liberty street, New York city. This bureau was established in 1879 by the present proprietor, Benjamin R. Weston, the object being to carry the entire burden of advertising for manufacturers of machinery and supplies who wish this branch of their business placed on a systematic and economical basis, and who have not the necessary time and experience to do it themselves. The pamphlet will be sent free upon request.

The stock lists issued by the Scully Steel and Iron Company, Chicago, Ill., will be found of great value to users of the goods this company handles, such as boiler, tank, and sheet-iron steel, galvanized steel sheets, ship and universal plate, lap-welded steel, and iron boiler tubes, bar iron and bar steel, corrugated and standing seam roofing steel, wire rope, screw punches, twist drills, reamers, tube expanders, machine tools, boiler-makers' hand tools, air compressors, and pneumatic tools. A copy of the company's stock list will be sent free upon application to readers of Marine Engineering.

Steam brass goods and specialties manufactured by the William Powell Company, 2525 Spring Grove avenue, Cincinnati, O., are described and illustrated in Catalogue No. 8. The catalogue states that this is the fifty-ninth year that the William Powell Company has been manufacturing engineering specialties. The first sixty-eight pages of this catalogue describe and illustrate valves of various sorts. Pages 69 to 91 are devoted to various kinds of lubricators. Oil feeders, oil cups, grease cups, water gauges, steam whistles, cylinder cups, gongs, injectors, etc., are described in the remainder of the catalogue.

Flake graphite for marine lubrication.—The Joseph Dixon Crucible Company, Jersey City, N. J., is distributing a folder which states that flake graphite serves a purpose in marine-engine lubrication which is peculiar to itself. Among the advantages claimed are that this company's flake graphite cools hot bearings and keeps them running continuously cool when other lubricants fail to prevent excessive friction; that when flake graphite is regularly used for the lubrication of main or connecting-rod bearings that there is an end to all friction troubles. Flake graphite used for swabbing rods and valve stems is claimed to save packing and to prevent leakage.

Pop safety and relief valves, pressure and vacuum gauges, are described and illustrated in 120-page Catalogue No. 12, issued by the Ashton Valve Company, 271 Franklin street, Boston, Mass. Regarding the Ashton patents the catalogue states that they cover the most valuable improvements in pop safety valves and gauges made in recent years, and that it has been the aim of the company to devise the most efficient and durable goods possible. The company keeps itself fully informed of all inventions of others, and does not hesitate to purchase such as are of value. This company also manufactures blow-off valves, chime whistles, pressure and vacuum gauges, revolution counters, marine clocks, test pumps, thermometers, and engine and boiler specialties in general.

"The July issue of Air Power," devoted to compressed air and its uses, and published by the Rand Drill Company, 128 Broadway, New York city, contains a complete description, illustrated by diagrams, of a displacement pump, by Prof. E. G. Harris; a description of a recent installation of a compressed air mine haulage system, by A. A. Bowman, M.E.; "The Uses of Compressed Air in the Wood-Working Shop," by W. R. Hulbert, M.E.; a description of the construction of the new Duluth aerial bridge; an article on the Philadelphia high-pressure pumping plant; an article on air compressor foundations, by E. M. Mackie, M.E.; three new inventions, as follows: A new tunnelling machine, a pneumatic stake driver used by Barnum & Bailey, and a device for conveying hot rivets through a metal tube by compressed air.

Variable speed motor drives, capable of being worked in with regular shop equipment, are manufactured by the Northern Electrical Manufacturing Company, Madison, Wis. This company has a special bulletin devoted to the application of motor drive to machines originally built for belted operation. A copy of this bulletin will be sent free upon application.

The marine gasoline motors built by the Mianus Motor Works, Mianus, Conn., are described in an illustrated catalogue this company is distributing. Among the advantages claimed for this motor are simplicity, ease in starting, perfect regulation of speed, accessibility, improved ignition and lubrication, absence of a reversing propeller or clutch, and perfect finish.

A free souvenir catalogue will be sent free to every reader of MARINE ENGINEERING who will write to the Independent Pneumatic Tool Company, First National Bank Building, Chicago, Ill. This catalogue is pocket size, neatly printed, and contains nearly fifty pages which are devoted exclusively to handsome illustrations and concise descriptions of the several kinds of pneumatic tools which this company manufactures. They include piston air drills, pneumatic hammers, air turbines, flue rollers, etc.

Boiler room economy is the subject of a pamphlet issued by the William B. Pierce Company, 327 Washington street, Buffalo, N. Y. The pamphlet states: "Boiler scale is costing you more money than your fuel bills come to. You can't fight scale by chemical means." The pamphlet states that the Dean boiler-tube cleaner, manufactured by the William B. Pierce Company, will thoroughly clean the tubes, and that the company will loan the cleaner free of charge in order that the user may form his own judgment of the value of the device before purchasing.

Steering wheels, steering quadrants, launch, and other wheels, are described in illustrated catalogue No. 22, issued by the Edson Manufacturing Company, 266 Atlantic avenue, Boston, Mass. Regarding its side-steering quadrant the catalogue states that this will appeal to the man who runs his motor and controls the direction of the boat at the same time. The quadrant is provided with a handle, the rim of which contains two scores to carry the forward and aft tiller rope. At the end of the quadrant rim are thumb screws by which the slack of the rope is taken up.

Globe, angle, cross, 60°, and check valves, are described and illustrated in a catalogue issued by the Hancock Inspirator Company, 85 Liberty street, New York city. The catalogue states that these valves are designed to meet the demand of steam and mechanical engineers for high-grade valves adapted to the highest steam pressures. All this company's valves are tested and guaranteed tight under a hydraulic pressure of 1,000 pounds, and are capable of standing an ultimate stress of 4,000 pounds without distortion, which, when placed under a steam pressure of 500 pounds, would leave a large factor of safety.

Lifting magnets are the subject of an illustrated 24-page pamphlet issued by the Electric Controller and Supply Company, Cleveland, O., The pamphlet states: "You can save 25 to 50 percent by using lifting magnets in handling pig iron, steel or iron scrap, baled or loose tin scrap, bolts, nuts, rivets, plates, billets, blooms, slabs, cold ingots in quantities, rails, pipe sheets, or other special shapes in quantities." The No. 1 pig magnet, the pamphlet states, will handle an average of 500 pounds of pig iron per lift, no labor being required except that of the crane operator. Regarding the factor of safety the pamphlet states: "Magnets never slip; chains often slip."

Whittelsey double-frame construction, for the hulls of high-grade gasoline launches, is described and illustrated in a folder issued by the Williams-Whittelsey Company, Long Island City, N. Y. The folder states that this construction is that used in building the 60-foot racing auto boat *Standard,* which is said to be as sound as ever after two racing seasons. The construction in question consists of two spring frames with longitudinals bound between them and through-riveted—the planking edges landing on the longitudinals to the full length of the hull. A boat so constructed will, it is claimed, hold form and remain rigid independent of its planking or ties, thus allowing the planking to be reduced to a minimum.

Automatic grab buckets, manufactured by the Browning Engineering Company, Cleveland, O., are illustrated and described in Bulletin No. 7 this company is distributing.

The Taunton-New Bedford Copper Company, New Bedford, Mass., is distributing literature calling attention to its copper and non-corrosive yellow metal, which, it states, is unequal for high-class marine work.

A time saver in the machine shop.—Leveling jacks are described in a folder issued by the Binsse Machine Company, Newark, N. J. The folder states that these jacks are adjustable to any desired refinement, that they are perfectly solid and unyielding under the strap pressure, and that one can raise or lower any point of the work. This last point, it is claimed, is a great advantage.

A "Treatise on Tool-Room Grinding and Grinding Machines," is the latest publication issued by the Cincinnati Milling Machine Company, Cincinnati, O. It is neatly printed and fully illustrated, and contains much valuable information regarding the grinding of tools and grinding machines. Every reader of Marine Engineering wishing a copy can have one sent free by mentioning this publication.

Forstner bits, manufactured by the Progressive Manufacturing Company, Torrington, Conn., are described in a folder this company is sending out. The statement is made that "the Forstner bit, unlike other bits, is guided by its circular rim instead of its center, so that it will bore any arc of a circle, and can be guided in any direction, disregarding the grain or knots, and leaving a true polished surface."

The Shaw propeller, manufactured by the Shaw Propulsion Company, 52 Broadway, New York city, is described and illustrated in a folder this company is distributing, which states that this wheel has many novel features; that it has less resistance in the water, and the least amount of friction, thus giving it the greatest driving power. It is claimed that this wheel has the same power on the reverse as on the forward movement.

A "Book News Service" is issued by the Derry-Collard Company, 256 Broadway, New York city. The company states that there will be no periodical date for its appearance, but that it may be published daily, weekly, or monthly as necessity may determine. It will contain short reviews of new books of interest to engineers, boilermakers, and technical men. Anyone writing the Derry-Collard Company and mentioning Marine Engineering will be put on the free mailing list.

Power boats, rowing and sailing craft, two- and four-cycle motors, speed launches, and cabin cruisers, are described and illustrated in a 40-page catalogue published by the Fairbanks-Grant Manufacturing Company, Ithaca, N. Y. The catalogue states that this company has a new factory equipped with up-to-date machinery, that it employs only the most skillful mechanics, and that it has perfected a new device which places the motor under perfect control at all times and by which the speed of the boat can be increased, decreased, or reversed instantly.

The American consul at Prague, Bohemia, writes to Marine Engineering asking that manufacturers and dealers who wish foreign trade forward to him copies of their catalogues and all trade literature for filing in the consulate. The consul asks that each correspondent give the firm or company name, street, city, and cable address, codes used, export discounts and terms, languages of correspondents, references or commercial rating, nature of exports, list of foreign branches and agents, together with complete information permitting immediate sales. All of this information will be filed without charge, and made use of to the best advantage possible for correspondence.

BUSINESS NOTES.

"THE ONLY WRENCH MADE which will turn pipe lying on a flat surface," is the claim made by the Bullard Automatic Wrench Company, Providence, R. I., for its drop-forged steel wrench.

THE DAYTON PNEUMATIC TOOL COMPANY, Dayton, O., has opened an office at 421 Market street, San Francisco, Cal., which will be in charge of Mr. Henry Engels.

H. A. ROGERS COMPANY, 19 John Street, New York city, manufacturer of Moncrieff Scotch gauge glasses, engineers' supplies, and general machinery agents, states that it has recently ordered several car loads of machine tools from Cincinnati concerns.

SEXTANTS, OCTANTS, BINNACLES, boat binnacles, peloruses, liquid compasses, dry compasses. and other nautical instruments are manufactured by the Keuffel & Esser Company, 127 Fulton street, New York city. A nautical catalogue will be sent free upon application.

"THE DUNTLEY AIR-COOLED ELECTRIC DRILLS are a valuable addition to the equipment of all vessels and shipyards," is stated by the Chicago Pneumatic Tool Company, Fisher Building, Chicago, Ill. This company makes a complete line of pneumatic appliances and storage batteries.

THE BOX COMBINED HAND AND STEAM WINDLASS is advertised by Alfred Box & Company, Front, Poplar, and Canal streets, Philadelphia, Pa,, who make the statement that this is the most efficient type of windlass on the market, and that it takes up less room on deck and costs less than other makes.

THE BLACKBURN SMITH FEED WATER FILTER and grease extractor is advertised by the Greacen-Derby Engineering Company, Perth Amboy, N. J. The company states that this device is the result of years of experience. That the water is forced through a substance (which may be renewed when foul) that absorbs every drop of oil.

A SATISFACTORY LUBRICANT.—Adam Cook's Sons, 313 West street, New York city, have received the following letter from L. P. Harvey, Clare, Ill., regarding a test of Albany grease: "I put the cup on the wrist-pin of an engine that had always given much trouble, and immediately the pin ran cool, and has done so ever since, although it is badly overloaded."

UNITED STATES METAL POLISH is manufactured by George W. Hoffman, 295 East Washington street, Indianapolis, Ind. Mr. Hoffman states that this polish works quickly and easily and keeps its luster, and that it has been on the market for twenty years. A free sample will be sent to all applicants mentioning MARINE ENGINEERING.

"A GOOD, SUBSTANTIAL BOLT, for use where the fire is hot and the strain severe," is advertised by the Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y., which states that it makes everything in bolts and nuts, cold-punched, case-hardened, trimmed, and semi-finished nuts for use in shipyards, engine shops, etc.

FREE SAMPLE OF MAGNETIC PACKING.—That Smooth-On cement rubber packing is magnetic may be proved by any one who will send to the Smooth-On Manufacturing Company, Jersey City, N. J., for a free sample of its cement rubber packing, which will be forwarded in a neat leather case together with a small magnet, to those who mention MARINE ENGINEERING. It will be found that this packing, though as smooth and soft as rubber, contains so much iron that the magnet will hold it suspended in the air.

NICHOLSON SHIP LOGS.—The Nicholson Ship Log Company, 204 Superior street, Cleveland, O., in advertising its ship log states: "You do not have to guess at the speed of your vessel if equipped with the Nicholson log. The exact speed of the moment is constantly before you on a dial and is recorded on a paper chart. The distance traveled is correctly shown on a counter. Guaranteed to register within 2 percent. No expense to operate if not abused. Wind the clock once a day and it will work automatically."

THE DIAMOND STEAM FLUE BLOWER (Hodge patent) is advertised by the Power Specialty Company, 520 Washington street, Detroit, Mich. This blower will be sent on trial, and the claim is made that by its use a boiler can be cleaned in five minutes, and that it absolutely prevents the accumulation of scale. It is used by the Pittsburg Steamship Company, the Standard Oil Company, the Montreal Transportation Company, and by many other transportation companies.

"ALWAYS MAINTAINS ITS WORLD-WIDE REPUTATION," is the statement made regarding P. P. P. packing, manufactured by the Quaker City Rubber Company, Philadelphia, Pa. The claim is made that this is the only real self-setting packing made tight by the pressure of steam trying to escape, and that it is only tight during that portion of the stroke when this condition exists. In the language of engineers, so states the company, "self-setting" means the packing that once put in requires no attention for months at a time. Such a claim is made for the P. P. P. packing.

"SAVES ONE MAN AND TONS OF COAL," is the statement made by the Northern Electrical Manufacturing Company, Madison, Wis., regarding its motor-driven hoists for yard service. Hoisting service is but one class of work for which this company builds special motors, other motors being built for machine tools, pumps, blowers, compressors, fans, etc.

AN INDICATOR FREE.—The France Packing Company, Tacony, Philadelphia, Pa., manufacturer of metallic fibrous and sheet packing, will send any engineer mentioning MARINE ENGINEERING particulars telling how he can obtain, free of cost, a Crosby, Tabor, or American-Thompson indicator, and also five hundred other things, which, the company states, include every article, tool, or device used by engineers.

BEARING METAL AND GRAPHITE, ribboned and pressed into rings, is advertised by the Pennsylvania Metallic Packing Company, Pittsburg, Pa. The company states that this packing is flexible, sensitive and frictionless, that no grease or adhesive substance is used, and that it is especially suitable for superheated steam, its melting point being 1,200 degrees.

"THE REASON YOUR DEALER TRIES TO SELL YOU a 'just as good' packing, is because his profits are 50 percent greater on the imitation kind," says the Peerless Rubber Manufacturing Company, 16 Warren street, New York city, manufacturer of rainbow packing. The company states that this packing cannot blow out, and that it makes a perfectly tight joint for air, steam, hot or cold water, gas, oil, or ammonia.

CHAIN PIPE WRENCHES.—J. H. Williams & Company, manufacturers of drop forgings, Brooklyn, N. Y., state that they have two kinds of chain to sell with the "Vulcan" chain pipe wrench, but that one of them is superior to the other. The company's flat link chains are from 25 percent to 50 percent stronger than its cable chains, which the United States and British governments have pronounced "unsurpassed."

KATZENSTEIN PACKING FOR THE RUSSIAN NAVY.—L. Katzenstein & Company, 358 West street, New York city, announce that they have sent a large consignment of their metallic packing to the Russian navy yards at Nicolaieff, and that they have also shipped a large order to A. G. Tecklenborg Company, Gesstemunde, Germany. In addition to this Katzenstein & Company fitted with their packing the main engines of the four ferryboats recently built for the Lackawanna line.

THE NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION's fifth annual convention will be held in connection with an electrical exhibition at Mechanics' Hall, Boston, Mass., July 15 to 22. The exhibition will include standard and special supplies and apparatus used for electrical house work, lighting, power work, and general construction. Requests for information and applications for space should be mailed to Chester Campbell, manager, 5 Park square, Boston, Mass.

FALLS HOLLOW STAYBOLT.—At the Master Mechanics' convention, Manhattan Beach, N. Y., in June, the Falls Hollow Staybolt Company, Cuyahoga Falls, O., exhibited hollow staybolt bars 10 feet long in various sizes, and samples of the raw material, which is a mixture of imported Swedish and native charcoal iron. The company also displayed threaded pieces of whole and solid iron, bent flat on themselves, the samples being nicked and broken to show the fiber of the finished product, and samples smashed flat endwise under a steel hammer, to demonstrate that Falls staybolt iron is not seamy.

A WELL-KNOWN SUBMARINE COMPOUND.—Samuel J. Williams & Company, 70 Broad street, New York city, report that they have been making anti-corrosive and anti-fouling compounds for iron and steel vessels for sixty-one years. The Williams compound is recognized as being of especial value in tropical waters. It is used by the United States navy and revenue cutter service, by the Old Dominion Line, the Red D Line, by the Pacific Mail Steamship Company, and by many other lines. The manufacturers have numerous agents and can give estimates on docking and painting at almost any dock in the world.

THE BENJAMIN ELECTRIC MANUFACTURING COMPANY, Chicago, Ill., manufactures electric clusters which are national code standard. The socket elements are on one base, and there are no wires. It is said that the cost of installation is greatly reduced, and that these clusters are especially adapted for use on shipboard.

THE EQUILIBRIUM CIRCULATOR is advertised by H. Bloomsburg & Company, 700 Dolphin street, Baltimore, Md. The company states that its circulator is just as important as an injector; that it prevents leaks of seams and rivets, that it prevents the deposit of sediment and the formation of scale, and that it increases the steaming capacity 15 percent.

IF THERE IS ANY PLACE on the face of the earth where space is at a premium it is on shipboard. That is why, says the B. F. Sturtevant Company, Hyde Park, Mass., that the Sturtevant vertical cross-compound generating sets represent the maximum of efficiency and the minimum of weight and space occupied for a given output. The statement is made that the 100 Kw. set, typical of a line of five sizes ranging from 17 1-2 Kw., showed a combined efficiency of more than 86 percent operated with less than 31 pounds of water per Kw. hour, weighed less than 190 pounds per Kw. of continuous output, and was compressed into nearly 10 percent less space than was allowed by the specifications.

NEW TOOL STEEL.—The Sheffield Steel Makers, Limited, Sheffield, England, are putting on the market a new kind of tool steel known as "Unor." This steel is intended not so much for rapid-cutting tool steel as to occupy an intermediate position, thus giving it many requirements which have not hitherto been well supplied in tool steel. The cutting and wearing capacity of this steel, it is believed, ranges between that of the old type of self-hardened steel and the best of the modern high-speed steel. "Unor" is sold at a price far below that usually charged for rapid-cutting tool steel. The Sheffield Steel Makers are also putting on the market a new kind of tool steel which is intended to maintain a cutting edge longer than anything of the kind hitherto produced. Some remarkable tests are reported of this new steel, and any information regarding it or "Unor" can be had upon inquiry of the manufacturers by referring to MARINE ENGINEERING.

SHIP AND YACHT FURNISHINGS, carpets, furniture, draperies, silverware, bed and table napery, cushions, galley outfits, and pantry stores, are furnished by Siegel Cooper Company, Sixth avenue, New York city, which makes a specialty of promptness and attention to detail.

THE STRENGTH, DURABILITY, non-elasticity, flexibility, and non-rotting qualities of Durable wire rope have made it famous the world over for hawsers, tiller ropes, etc., says the Durable Rope Company, 26 Atlantic avenue, Boston, Mass. The statement is made that when stays and rigging of durable wire rope have once been made taut and ship-shape, that they remain so. A free sample will be sent to any applicant mentioning MARINE ENGINEERING.

J. H. WILLIAMS & COMPANY, manufacturers of drop forgings, 150 Hamilton avenue, Brooklyn, N. Y., have opened a branch store at 19 South Clinton street, Chicago, Ill., where the company will carry in stock a complete line of its drop forged wrenches, Vulcan chain pipe vises, lathe dogs, eye bolts, and other drop forged specialties, including specimens of the company's special drop forgings, illustrating the variety of work it is doing in this line. J. H. Williams & Company invite all their friends to call at the new store, and suggest that orders and correspondence from the middle west be forwarded to the Chicago office.

A NEW TYPE OF LIGHT-DRAFT, TWIN-SCREW STEAMBOAT.—The Marine Iron Works, Station A, Chicago, Ill., reports that it has received an order from a foreign country for an unusual type of light-draft, twin-screw steamboat. The first of these boats, which will be but 55 feet in length, is to be made of galvanized steel throughout and fitted with two fore-and-aft compound condensing high-speed engines, with a water-tube boiler burning crude oil and allowing 250 pounds steam pressure. The machinery is capable of indicating 70 horsepower. The twin propeller wheels will work in tunnels of unique arrangement entirely different from the ordinary type of "tunnel boat." This boat will draw but 18 inches of water although 24-inch propeller wheels of special design will be submerged in the tunnels. In addition to the light draft and increased efficiency of the wheels, the tunnel arrangement provides against accident from snags or other obstructions.

CONSOLIDATION OF DRILL COMPANIES.—The Rand Drill Company, 128 Broadway, New York city, and the Ingersoll-Sergeant Drill Company, 26 Cortlandt street, New York city, have united and formed a new corporation under the name of the Ingersoll-Rand Company, with a capital stock of $10,000,000. The factories of the two companies are located at Phillipsburg, N. J.; Easton, Pa.; Tarrytown, N. Y.; Painted Post, N. Y.; Ossining, N. Y.; New York city, and Sherbrooke, Quebec, Canada. The officers are: W. L. Saunders, president; George Doubleday, Jasper R. Rand, John A. McCall, J. P. Grace, George R. Elder, W. R. Grace, vice-presidents; and F. A. Brainerd, secretary. The main offices of the company will be at 26 Cortlandt street, New York city.

A NEW SQUARE AUGER AND MORTISING MACHINE has been placed on the market by the American Compressed Steel Company, Arcade Building, Philadelphia, Pa. The claim is made that this is the only auger that makes a square hole or mortise with a rotary motion; that it is the only auger that bores out wood in one portion leaving clean-cut corners; that it is the only auger that is lubricated continually from an oil reservoir; that it is the only tool with which one can make a mortise at any desired angle on the timber, or endwise of the grain; that it is the only auger that will cut any kind of a knot without injury; that it is the easiest auger to sharpen, and that it is also a superior tool for boring round holes. This auger has received a gold medal from the Nineteenth Triennial Exhibition of the Massachusetts Charitable Mechanical Association, which reported: "During this exhibition the auger was worked in knotty maple, oak, spruce, ash, chestnut, hard pine and white wood. The members of the board of judges were all practical mechanics with large experience in wood-working machines, and their opinion is expressed by the award of the gold medal."

MARINE ENGINEERING
EMPLOYMENT BUREAU

Full information regarding the purposes of this Bureau, together with instructions regarding registration, etc., furnished upon application to MARINE ENGINEERING Employment Bureau, 17 Battery Place, New York city.

All correspondence, concerning either vacancies or situations wanted, is strictly confidential.

MEN SEEKING POSITIONS

We have applications registered for positions as follows, and the references of each applicant have been carefully investigated:

ASSISTANT OR SUPERINTENDING ENGINEER to shipping concern or factory seeks position; is 30 years old, married, and has had several years experience at sea as chief engineer. Application No. 100.

BOILER-MAKER FOREMAN seeks position. Is at present foreman of railroad shops and has charge of nearly one hundred men; has had twelve years' experience as foreman; posted in the latest boiler practice; has best references as to ability and character; is 38 years old. Application No. 73.

BOILER-SHOP FOREMAN. Age 35; single; many years' experience in Navy Yard and leading shipyards. Application No. 59.

BOILER-SHOP FOREMAN. Age 37; single; 16 years' experience in boiler-shop work. Application No. 47.

CHIEF OR ASSISTANT CHIEF DRAFTSMAN—ENGINE. Age 33; married; has had sea experience and thirteen years as leading and chief draftsman of private and government shipyards. Application No. 25.

CHIEF DRAFTSMAN OR SUPERINTENDING ENGINEER seeks position. Has had extensive experience in several of the best known shipyards, and can furnish the best of references. Application No. 81.

CHIEF DRAFTSMAN OR CHECKER seeks position; is 36 years old; married; was with the Carnegie Steel Company for about three years; later with the National Steel Company, and with the American Bridge Company. Application No. 79.

DESIGNER, EXPERIENCED, of dredges and other types of vessels, seeks position; is 28 years old; has had 10 years of experience in Great Britain and this country in leading shipyards. Application No. 82.

DESIGNER AND DRAFTSMAN. Has had many years' experience in launch and river boat work. Designed some of the fastest river boats in the country. Application No. 61.

DRAFTSMAN. Position in a drafting office desired by a young man just finishing his course in naval architecture. Application No. 108.

DRAFTSMAN seeks position; has had long experience in designing, including main and auxiliary engines for torpedo-boat destroyers for the British Admiralty, and some of the best suction dredges that have been built in Great Britain. Best of references in this country. Application No. 111.

DRAFTSMAN, ENGINE AND BOILER. Age 30; unmarried; has Danish marine license; technical school graduate. Application No. 57.

DRAFTSMAN—HULL. Age 20; single; experienced in architectural work, but prefers marine drafting. Application No. 51.

DRAFTSMAN—HULL, OR INSPECTOR. Age 37; married; had experience both in government yards and private yards. Application No. 30.

DRAFTSMAN—HULL. Age 22; single; born in Norway; studied Technical schools in Norway and Germany; experience as draftsman, also as shipfitter. Application No. 31.

DRAFTSMAN—HULL AND ENGINE. Age 26; single; graduated Webb Academy; has had four years' experience in navy yard work; desires connection with private shipyard. Application No. 41.

DRAFTSMAN—ENGINE, STEAM OR GAS. Forty-three years old; single; born in Germany; has had extensive experience in designing and drafting; has had sea experience. Application No. 32.

DRAFTSMAN, ESTIMATING, seeks position; age 30; single; graduate of the Virginia Polytechnic Institute; has had several years' experience in well-known shipyards. Application No. 110.

DRAFTSMAN—MARINE. Age 34; married; accustomed to intricate drafting work. Application No. 50.

DRAFTSMAN, MECHANICAL, capable of designing and computing, age 31, seeks position in connection with hull and engine work. Has had experience in government work; also in well-known shipyard. Application No. 114.

DREDGE DESIGNER seeks position; has had 10 years' experience in designing and building dredges of all kinds. Application No. 99.

DREDGE OR SHIPBUILDER who has had 20 years of experience in calculating and designing in connection with dredges and other vessels seeks position. Application No. 83.

GANG FOREMAN IN ERECTING SHOP OR FITTING UP ENGINES IN SHIPS. Age 37; married; has been with present employers 15 years. Application No. 26.

GAS ENGINE DRAFTSMAN seeks position; is 27 years old; married; technical-school graduate; has had several years' sea experience, as well as a number of years of special work in connection with gas engines; has had experience in building these engines up to 1,500 horsepower; thoroughly posted on all office detail and laying out work. Application No. 97.

GAS ENGINE OPERATOR. Age 28; single; born in Germany; 7 years' experience; understands naphtha engines of Gas Engine and Power Co. thoroughly. Application No. 48.

HULL SUPERINTENDENT. Age 42; married; born and learned trade in Scotland, studied at Glasgow School of Naval Architecture, experienced as foreman; surveyor and hull superintendent. Application No. 27.

LAUNCH AND YACHT SUPERINTENDENT AND DESIGNER. Age 34; married; has had about fifteen years' experience in some of the best known launch and yacht building establishments in the country. Application No. 62.

LEADING DRAFTSMAN OR SUPERINTENDING ENGINEERING FOR STEAMSHIP LINE. Age 34; married; studied Massachusetts Institute of Technology; 11 years' experience in drafting and other marine work. Application No. 53.

LOFTSMAN. Age 33; single; has had eight years' experience as loftsman, foreman, and draftsman. Application No. 44.

MARINE MAN, EXPERIENCED, with excellent recommendations seeks outside position in shipyard or to represent some manufacturing concern or launch builder; is 39 years old and single. Application No. 78.

MASTER OF STEAM YACHT. Age 37; married; born in Norway; has license as master and pilot on ocean steamer; has commanded several well-known yachts. Application No. 40.

MASTER OF SHIP OR YACHT. Age 40; 7 years' experience; has first class master's license for all ocean and coastwise steamers and pilot for most harbors on the coast. Application No. 39.

MASTER OR PIER SUPERINTENDENT. Age 38; has spent whole life at sea and has British Extra and American master's certificate; pilot New York and San Francisco; experience in handling men and cargoes. Application No. 35.

MASTER AND PILOT. Age 44; single; 11 years' experience; has license for 500 tons as master and pilot ocean and inland for New York, New Haven, and New London districts. Application No. 20.

MASTER OR PILOT seeks position, preferably on a houseboat. Has had 43 years' sea experience in all parts of the world. Is well acquainted with the inside route from New York to Florida, and with all the waters of Florida and adjacent lines. Best of references. Application No. 115.

OILER. Who has had experience on one of the well-known coastwise lines seeks position. Application No. 64.

OILER seeks position to learn marine engineering; is single; 22 years old; well educated and has had considerable mechanical experience. Application No. 77.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line or fraction thereof, for the first insertion, and twenty-five cents per line for each subsequent insertion. Lines average ten words each. The heading counts as a line, as does also the address.

DRAFTSMEN WANTED.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur. Wants men now employed. Give full experience and reason for changing. Shop experience great advantage. All letters acknowledged and held confidential. M. M., care MARINE ENGINEERING, 17 Battery Place, New York.

POSITION WANTED.

Designing Marine Engineer, 41 years of age, married, desires to change position as Chief Engineer or Chief Draftsman. Fifteen years with present employers. Active, energetic, capable of handling a large number of men. Excellent references and good reasons given for wishing to change. Address ENGINEER, care MARINE ENGINEERING, 17 Battery Place, New York.

STEAM-TURBINE MOTORS, DYNAMOS, blowers, centrifugal pumps, and electro-motor centrifugal pumps are advertised by the De Laval Steam Turbine Company, Trenton, N. J.

THE PASSING OF THE TANK BOILER.—In discussing this subject, Mr. Egbert P. Watson says: "It is an easy matter to build a new steam boiler, especially one of a new type. This must be true, or else there would not be so many amateur engineers rushing in where professional engineers fear to tread. It seems to be chiefly a matter of drawings and blue prints. If these last are numerous enough and so clear that a boiler maker cannot make mistakes, the worst seems to be over. The resistance of heating to grate surface is all right and such as prescribed by the best modern practice. The products of combustion can go only one way square upon the heating surface, and these last where sheets or tubes are combined to take up the heat and pass it on to the water. The facts in the case of steam boilers are that the best designers are sometimes at fault in exploiting a new one. Sometimes a very slight thing which is overlooked will put a boiler out of commission. It requires time to develop a new type of boiler; weak points have to be eliminated and strong ones brought out. The Babcock and Wilcox boiler was a new type forty years ago, and it will surprise many who have not given the subject much attention to learn that it has been in existence so long. In forty years, by assiduous investigations into causes of unsatisfactory working in all directions, and by the employment of the best engineering talent that could be obtained, it has been brought to its present efficiency."

CHICAGO PNEUMATIC TOOLS IN EUROPE.—Mr. J. W. Duntley, president of the Chicago Pneumatic Tool Company, Chicago, Ill., has returned from Europe, bringing with him orders for 3,400 tools for shipment from America, representing a value of over $300,000. Mr. Duntley states that the trip was the most successful he has ever experienced, and owing to the growing demand for pneumatic tools in England and on the continent, it was found necessary to extend the organization of the foreign business. In order to accomplish this the factory and business of E. G. Eckstein, Berlin, Germany, and that of the Lencke Company, St. Petersburg, Russia, were purchased and will be operated for the purpose of meeting these requirements in the continental countries. Pneumatic tools are rapidly being introduced in shipbuilding and other industries in Russia, Austria, Germany, Italy, and France, and a large increased demand for the various devices is anticipated. The line of electric drills exhibited and demonstrated was extremely successful, and large orders were received. Owing to the fact that all European countries are well equipped with electricity, the electric drill is destined to rival the air drill in time, and opens up a field which heretofore could not be solicited. The profits earned through the extension of the foreign business will accrue to the benefit of the Chicago company. The English courts, on May 17, rendered the final adjudication of the patent litigation instituted by the English company, which decision sustained all of the company's claims, fifty-two in number, covering pneumatic hammers, thus leaving the English company in a particularly strong position with reference to its patents. Its plant, located at Fraserburgh, Scotland, is now in full operation. The American business, according to President Duntley, shows a very satisfactory increase in volume, and all factories, both American and foreign, are operating overtime. The month of May was the largest month in the history of the company.

The Reason your dealer tries to sell you a "JUST AS GOOD" as

RAINBOW PACKING

is because his profits are 50 per cent. greater on the imitation kind.

THE ENGINEER'S FRIEND

¶ State clearly on your packing orders RAINBOW and be sure you get the genuine. Look for the trade-mark, three rows of diamonds in black, in each one of which occurs the word RAINBOW.

¶ RAINBOW PACKING is the most satisfactory packing ever made. Can't blow RAINBOW out. Makes a perfectly tight joint for air, steam, hot or cold water, gas, oil or ammonia.

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THE

Peerless Rubber Manufacturing Company

16 WARREN STREET, NEW YORK

16-24 Woodward Ave., Detroit, Mich.
210-214 N. Third St., St. Louis, Mo.
1218 Farnam St., Omaha, Neb.
202-210 S. Water St., Chicago, Ill.
Cor. Common and Tchoupitoulas Sts., New Orleans, La.

1621-1639 17th St., Denver, Colo.
220 South Fifth St., Philadelphia, Pa.
17-23 Beale St. and 18-24 Main St., San Francisco, Cal.
Cor. Ninth and Cary Sts., Richmond, Va.

16 & 18 S Capital Ave., Indianapolis, Ind.
1221-1223 Union Ave., Kansas City, Mo.
709 711 Austin Ave., Waco, Tex.
51-55 N. College St., Charlotte, N. C.
634 Smithfield St., Pittsburg, Pa.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

12 West 31st Street, New York.

President, FRANCIS T. BOWLES.
Secretary-Treasurer, W. J. BAXTER.
Executive Committee, LEWIS NIXON, EDWIN A. STEVENS, HARRINGTON PUTNAM, STEVENSON TAYLOR. *Ex-officio*, FRANCIS T. BOWLES, W. J. BAXTER.

AMERICAN SOCIETY OF NAVAL ENGINEERS.

Navy Department, Washington, D. C.

President, Commander A. F. DIXON, U.S.N.
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MARINE ENGINEERS' BENEFICIAL ASSOCIATION.

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Vice-President, CHARLES W. ROBINSON, 908 G. St., N. W., Washington, D. C.
Second Vice-President, EVANS I. JENKINS, 153 Clinton St., Cleveland, Ohio.
Secretary, GEORGE A. GRUBB, 1318 Wolfram St., Lake View, Chicago.
Treasurer, ALBERT L. JONES, 289 Champlain St., Detroit, Mich.
Advisory Board, WILLIAM F. YATES, 120 Liberty St., New York city; GEORGE F. KEATING, 74 Webster St., East Boston, Mass.; W. D. BLAICHER, 10 Exchange St., Buffalo, N. Y.

ADDRESSES OF CORRESPONDING SECRETARIES.

No. 1, W. D. Blaicher, 10 Exchange St., Buffalo, N. Y.
" 2, Wm. Kelly, 11 Wall St., Cleveland, O.
" 3, A. L. Jones, 289 Champlain St., Detroit, Mich.
" 4, James A. Macauley, 5802 Indiana Ave., Chicago, Ill.
" 5, Otto Boettger, 1035 E. Hopkins Ave., Baltimore, Md.
" 6, Wm. Arste, 322 Pine St., St. Louis, Mo.
" 7, Wm. T. McElwee, Box 1556, Portland, Me.
" 9, Wm. Bridges, 784 1-2 12th St., Milwaukee, Wis.
" 13, John G. Paulding, 1746 Tulip St., Philadelphia, Pa.
" 14, Joseph F. Dumas, 403 Dauphin St., Mobile, Ala.
" 15, R. L. Skinner, 622 Louisa St., New Orleans, La.
" 17, Jas. D. Robinson, 6th and Columbia Sts., Newport, Ky.
" 18, Wm. Hurst, 715 Walnut St., Cairo, Ill.
" 20, Jos. B. Barry, 206 Keel St., Memphis, Tenn.
" 21, J. H. Foley, 206 N. Mulberry St., Vicksburg, Miss.
" 23, Wm. R. Lewis, 213 E. Front St., Jeffersonville, Ind.
" 24, Hugh L. Edwards, 511 Washington St., Paducah, Ky.
" 26, T. H. Kirkbridge, 228 Bond St., Evansville, Ind.
" 27, L. C. Schwall, 598 S. Madison St., Bay City, Mich.
" 29, James R. Sutherland, Charleston, W. Va.
" 30, E. R. Humphrey, 21 State St., Pittsburg, Pa.
" 33, James J. Waters, 21-24 State St., New York, N. Y.
" 35, William M. Coombs, 36 East St., San Francisco, Cal.
" 36, Jos. Thomas, 57 Sea St., New Haven, Conn.
" 37, John B. Bender, 1215 Evesham Ave., Toledo, Ohio.
" 38, C. H. Wolford, 73 Starr Boyd Bldg., Seattle, Wash.
" 39, Frank Feeney, 460 E. 12th St., Erie, Pa.
" 40, Chas. Drouet, 1003 Ave. I, Galveston, Tex.
" 41, W. H. Marshall, 343 Holladay St., Portland, Ore.
" 42, Jas. Manning, 802 E. Duval St., Jacksonville, Fla.
" 43, A. J. Wilson, 1327 La Peer Ave., Port Huron, Mich.
" 44, Chas. J. Sullivan, 480 1st St., Manistee, Mich.
" 45, W. L. Salter, care O. S. S. Co., Savannah, Ga.
" 46, D. W. Farrell, Clayton, N. Y.
" 47, J. R. Cook, Sault Ste. Marie, Mich.
" 48, Alfred Hegemer, 140 E. Park St., Sandusky, O.
" 51, H. S. Connell, 12 Ranson St., Muskegon, Mich.
" 53, Harry Stone, Box 445, Marine City, Mich.
" 55, Archie Stalker, Box 883, Cheboygan, Mich.
" 57, E. B. Meeker, 71 Abeel St., Kingston, N. Y.
" 58, E. Capers Haselden, Box 31, Georgetown, S. C.
" 59, George F. Keating, 74 Webster St., E. Boston, Mass.
" 62, N. S. Lawrence, 30 Connecticut Ave., New London, Conn.
" 63, M. J. Burke, 152 Sheridan Ave., Albany, N. Y.
" 65, W. C. Palmer, care Consumers' Coal Co., Charleston, S. C.
" 67, James K. Dole, Saugatuck, Mich.
" 70, Charles T. Smith, 665 Commercial St., Astoria, Ore.
" 72, Wm. T. Findlay, 130 W. Bridge St., Oswego, N. Y.
" 73, E. M. Donahue, 1308 Cherry St., Green Bay, Wis.
" 75, Wm. D. Hemenway, Alexandria Bay, N. Y.
" 76, Orson Vanderhoef, Grand Haven, Mich.
" 77, John P. Hall, 1215 Huron St., Manitowac, Wis.
" 78, J. P. Burg, 2722 Minnesota Ave., Duluth, Minn.
" 80, Edward S. Welch, 338 Hamilton St., Albany, N. Y.
" 81, Jas. L. Sweeney, 206 E. Sarragosa St., Pensacola, Fla.
" 82, Fred H. Gowell, 427 Middle St., Bath, Me.
" 85, John A. Packard, 623 Merchant St., Alpena, Mich.
" 86, Sherman A. Smith, 737 Menekaunee Ave., Marinetta, Wis.
" 87, George B. Milne, 809 Fourth St., Detroit, Mich.
" 88, C. O. Chapman, S. B. Canal, Sturgeon Bay, Wis.
" 89, Geo. E. Willard, 4 Isabella St., Ogdensburg, N. Y.
" 91, A. L. McLaren, 130 W. Walnut St., Ashtabula, O.
" 92, Jos. D. Budd, Box 50, Sta. I, Saginaw, W. S., Mich.
" 93, W. J. Cook, 2220 G. St., N. W., Washington, D. C.
" 94, George R. Jones, Box 222, Washington, N. C.
" 95, P. J. McMahon, Box 199, Key West, Fla.
" 98, C. N. Vosburg, 6323 Patton St., New Orleans, La.
" 100, H. F. Mocine, Honolulu, H. I.
" 101, J. K. Cotton, Box 765, Norfolk, Va.
" 102, Fred. W. Linsemeyer, 210 Clinton St., South Haven, Mich.
" 103, A. E. Pittman, Box 378, New Bern, N. C.

TRADE PUBLICATIONS.

A 34-H. P., four-cylinder marine motor is described and illustrated in a folder distributed by the Trebbert Auto and Marine Motor Company, Rochester, N. Y.

Centrifugal pumping machinery is the subject of Catalogue No. 11, issued by the Morris Machine Works, Baldwinsville, N. Y. The introduction to this catalogue states that the company has built centrifugal pumps for thirty-six years, and during that time has turned out over 23,000 of all sizes and types.

A free copy of a 52-page catalogue will be sent to any reader of MARINE ENGINEERING who will write to the Schaffer & Budenberg Manufacturing Company, corner of Leo and Bedford places, Brooklyn, N. Y. The pages are 9 by 12 inches in size and are filled with illustrations of a great variety of boiler and steam-engine appliances, making the catalogue one of great interest to any man who has to do with boilers or steam engines. The many specialties illustrated include gauges of all kinds, testing instruments, thermometers, water columns, gauge cocks, valves in great variety, whistles, injectors and ejectors, steam traps, indicators, etc.

"Manila Rope Transmission and Hoisting, a brief treatise for engineers on ropes used for the transmission of power, together with formulæ, tables, and data," by C. W. Hunt, is published by the C. W. Hunt Company, West New Brighton, N. Y. This book is profusely illustrated and describes the manufacture of rope from the original fiber up to the finished product, including the description of rope manufacture and transmission as practiced in past ages. Numerous diagrams are also given showing the horse-power of Manila rope at various speeds, diagrams of various rope-driving devices, illustrations and descriptions telling how to splice a transmission rope, and much other useful information. A copy of this pamphlet will be sent free to those mentioning MARINE ENGINEERING.

The Wiet-Goethe caliper combination gauge is described and illustrated in a folder issued by Howard S. Moss, 34 Clark street, Chicago, Ill. The folder states: "Did it ever happen to you when called upon to perform some mechanical work to be confronted by almost insurmountable difficulties because you did not have handy the right kind of tool to take measurements? We now present to the trade a tool which will enable you to carry in your vest pocket all in one instrument an outside caliper, an inside caliper, a divider, a straight edge, an angle gauge, a depth gauge, a try square, a center square, an angle protractor, a center gauge, and many combinations too numerous to mention. This tool is made of superior steel carefully tested as to its accuracy." For a limited time, in order to introduce this gauge, Mr. Moss will send it postpaid to any address for $2.

"Boiler Room Economy" is the title of a little book issued by the William B. Pierce Company, 321 Washington street, Buffalo, N. Y. The book tells all about boiler scale, how it is formed, and advertises the Dean boiler-tube cleaner as the best way to remove scale. The Dean boiler-tube cleaner has been made for several years and a sale already secured exceeding 5,000 cleaners. In the list of users is noticeable the number of large concerns which use this cleaner, the Standard Oil Company using 40, the United States Steel Corporation over 100 in its various plants, the United States Leather Company over 50, etc. The William B. Pierce Company makes great claims for the Dean cleaner, and that any power user may see its own value in his own plant, it will loan a cleaner for trial in one boiler without obligation to purchase. "Boiler Room Economy" tells all about this trial offer and the Pierce Company will be glad to send it to anyone upon application, as well as to loan a Dean cleaner for trial in competition with any device used for the prevention or removal of scale. Ocean-going steamships have been badly bothered by scale at different times, and many have purchased the Dean cleaner. A recent inquiry from the chief engineer of the Japanese navy, from the advertising of the Pierce Company in this paper, shows the wide circulation of MARINE ENGINEERING as well as the foresight of the Japanese in keeping in touch with all that is best in mechanical device in this country.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS.

314 Madison Avenue, New York City.

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Louvet two-cycle gasoline motors are the subject of a folder issued by Louvet & Son, 248 Park Place, Woodhaven, N. Y.

The "Wizard" marine gas engine is described and illustrated in a folder distributed by John V. Rice, Jr., & Company, Bordentown, N. J.

"Little Giant" sparking batteries and automobile speed recorders are the subject of an illustrated folder issued by the Chicago Pneumatic Tool Company, Fisher Building, Chicago, Ill.

Atlas water tubes and Atlas medium-speed engines are described and illustrated in catalogues issued by the Atlas Engine Works, Indianapolis, Ind.

Air and gas compressors.—The Laidlaw-Dunn-Gordan Company, 114 Liberty street, New York city, is distributing a 175-page book describing and illustrating steam, electric, gas, and power-driven compressors.

Watertown automatic engines are described and illustrated in a catalogue issued by the Watertown Steam Engine Company, Watertown, N. Y.

Gates valves for steam and water, bent pipe work, tools and supplies of all kinds for steam, water and gas users are described in circulars distributed by the Walworth Manufacturing Company, 132 Federal street, Boston, Mass.

Pressure and vacuum gauges, ammonia gauges, pop safety valves, blow off valves, globe and angle valves, and other engineering specialties are illustrated and described in a folder issued by the Crosby Steam Gauge and Valve Company, 78 John street, New York city.

The "Valve World," Vol. I., No. 5, published by Crane Company, Chicago, Ill., manufacturer of valves and other steam specialties, contains articles on "Self-Packing Valves," "The United States Steam Dredge *San Pedro*," "Importations of Scotch Pig Iron," "Making Large Wrenches in Emergencies," "Trade News," and other articles of interest to engineers.

"Absolute protection is assured against boiler explosions from excessive pressure by the use of the American special pop safety valve," says the American Steam Gauge and Valve Manufacturing Company, 208 Camden street, Boston, Mass., in an illustrated folder it is distributing.

Marine gasoline engines and launches.—The Lamb Boat and Engine Company, Clinton, Ia., is distributing a number of folders, each illustrating and describing a boat and engine built by this company. These illustrations give a very clear idea of the class of work done by this company, and it will certainly pay intending purchasers of gasoline engines or launches to write for the company's literature.

The Hubbard gas engine is described in a 32-page illustrated catalogue issued by the Hubbard Motor Company, Middletown, Conn. Among the advantages claimed for the Hubbard motor are accessibility, simplicity, reliability, sensitiveness, and cleanliness. The catalogue states that it is the company's aim to make an engine of the most perfect type and still permit the claim of simplicity.

Metropolitan injectors are described in a 50-page illustrated catalogue issued by the Hayden & Derby Manufacturing Company, 85 Liberty street, New York city. The catalogue states: "This is an era of specialists, and we are specialists in injectors, ejectors, and jet apparatus. Our entire energy is devoted to the manufacture of Metropolitan injectors, H-D ejectors, water heaters, and jet apparatus fittings."

Northern electric emery grinders.—The Northern Electrical Manufacturing Company, Madison, Wis., has issued Bulletin No. 48, describing the company's electric grinder and buffer equipments. The Northern grinders are of special design and construction, including heavy crucible tool-steel armature shafts, liberal bearings, and dust-proof covers. They are equipped with speed-regulating devices so that the speed of the grinding and buffing wheels may be varied to compensate for the varrying diameters of the wheel. A free copy of this bulletin will be forwarded to all mentioning MARINE ENGINEERING.

The Sargeant steam meter, manufactured by the Sargeant Steam Meter Company, First National Bank Building, Chicago, Ill., is described and illustrated in a catalogue this company is distributing. The catalogue states that the device is an instrument for indicating the pounds of steam flowing through it irrespective of the pressure, that it shows at a glance the quantity of steam used by an engine, steam pump, heating system, or dry room. It is designed to be used for testing engines where surface condensers are unavailable, for testing the capacity of boilers, and for measuring the amount of steam used in each department of industrial plants.

BUSINESS NOTES.

SMOOTH-ON ELASTIC CEMENT is the latest product of the Smooth-On Manufacturing Company, Jersey City, N. J. This is an iron elastic cement prepared in paste form ready for use. Its advantages are said to be that it is metallic, and may also be applied to hot iron, the heat causing it to metallize instantly, making it valuable for stopping leaks. The Smooth-On Elastic Cement Instruction Book will be sent free of charge to anyone mentioning this magazine.

"LONG ARM" SYSTEM POWER DOORS IN LONDON.—Among the few American inventions which are displayed at the naval, shipping, and fisheries exhibition at Earl's Court, London, England, this summer, is a full-size working exhibit of the "Long Arm" system of electrically-operated watertight power doors made by the "Long Arm" System Company, Cleveland, O. This exhibition is said to have attracted much attention from naval experts who have visited the display. This system, from a central station located at a convenient point on the bridge of the ship, closes the doors and hatches of the vessel in time of emergency, providing for the local safety of men involved by a liberty action attached to each door. The device has now been installed on some thirty American men-of-war, and the admiralty departments of numerous foreign governments are interesting themselves in the system with the idea of placing it on their own ships. In addition to the exhibit at Earl's Court, there is another full-size working exhibit on display at 39 Victoria street, London, England.

A POPULAR GALLEY RANGE.—The popularity of the "Webbperfection" galley range, which not only roasts, cooks, and bakes, but supplies hot water, and at the same time permits the entire top of the stove to be used for cooking, is attested by the many orders received by Elisha Webb & Son, the manufacturers, and it is interesting to note the variety of vessels which they have lately equipped, among which have been the Standard Oil Company's barge *92*; steamship *Capt. A. F. Lucas*; schooner yacht *Elmina*; Peary Arctic Club's steamer *Roosevelt*; and the Sewall ship *Erskine M. Phelps*. In the case of the schooner yacht *Elmina*, a racing craft designed by Messrs. Cary, Smith & Ferris, the advantages of the hot- and cold-water system for bath, lavatory, and culinary purposes is obvious. There is no other agency on board for supplying hot water, and at the same time the yacht possesses a galley range which has an unobstructed top for cooking. This feature materially increases the capacity of the apparatus and adds to its efficiency. In the case of the Peary ship, Elisha Webb & Son not only supplied the galley range, but the entire plumbing system, consisting of porcelain tubs, lavatories, etc. The fresh water in this ship for ten months in the year is obtained by melting ice in a steel tank located immediately behind the range, and the cold-water supply for the various baths and lavatories is piped up by gravity system from the tank in question, the kitchen pump supplying the circulating boiler, which in turn supplies hot water by gravity to the various outlets. Arrangements are also made by which the gravity system can be dispensed with, and the baths and lavatories are supplied with hot and cold water by pressure system, operated by small steam pump. Elisha Webb & Son report the receipt of an order for a similar apparatus for the schooner yacht *Shepherdess*, building at Essex, Mass., for Mr. S. F. Houston, Philadelphia, from designs by B. B. Crowninshield, Boston, Mass. Mr. Houston will enjoy the advantage of hot and cold plunges and shower baths, which formerly were considered an impossibility on sailing yachts.

"GLADIATOR" HIGH-PRESSURE RING-PACKING, says the New Jersey Asbestos Company, Camden, N. J., is now being used by hundreds of engineers who never before could afford the luxury and convenience of packing in this form. This "Gladiator" packing is molded in steel dies under hydraulic pressure. The rings are very durable, and, being made of asbestos, will not burn or char, and, being molded to shape, they are accurate in size, clasping the rod snugly all around, thus often saving burned fingers and other troubles. The New Jersey Asbestos Company also makes many other asbestos specialties, such as asbesto-metallic sheeting, asbesto-metallic tape, asbestos mill-board, asbesto-metallic gaskets, asbesto-magnesia sectional steam-pipe covering, etc. Catalogue sent free upon request.

A NEW METALLIC PACKING.—The Garlock Packing Company, Palmyra, N. Y., has for two or three years investigated the metallic packing business of the country with the idea of going into the business itself. As a result the company has made an arrangement with the Pitt Manufacturing Company by which the Garlock Packing Company will operate the former company's plant at Elwood City, Pa. Mr. L. H. Martell, who has had fifteen years' experience in the manufacture of metallic packing, will remain as manager of the factory. By the addition of this plant the Garlock Packing Company is prepared to supply both fibrous and metallic packing suited for all engineering conditions.

SCALING CONDENSER PIPES WITH PNEUMATIC HAMMERS.—The Chicago Pneumatic Tool Company, Chicago, Ill., states that an important part of ice and refrigerating plants are the condensers, they being the medium through which the heat, absorbed from the water being frozen, or from the produce in storage, is finally disposed of. In the construction of ice and refrigerating plants great care is given to the condenser's design, to secure the best results in efficiency. Many times a plant is carefully designed, and highly economical results are obtained during the first few weeks of its operation, but slowly the cost of production increases until its profits are decreased to an alarming degree. Investigation usually shows that the management of the mechanical department is at fault, and that the machinery and devices about the plant are not receiving proper attention. Through neglect they become inoperative, thereby cutting down the output or increasing the cost of production. Water is always a questionable factor in a plant of this kind, and frequently is so scarce that plants cannot run to capacity or must be shut down a part of the time. Numerous devices are employed to overcome the water problem, many of which have great merit; yet frequently the condition of the condensers is not taken into consideration. They are up above somewhere and water runs over them. Many times all the water that can be pumped is sent over them, or through them, as the case may be. But still the compression gauge stands well up in the two hundreds, the ice in the moulds refuses to close, and the storage-room thermometers climb higher and higher. The cause of this condition is a simple one. The water used is impregnated with mud, alkali, magnesia, or some other substance, which has been daily deposited on the pipes of the atmospheric, or in the pipes of the double pipe condenser, and baked there by the heat of the compressed ammonia gas or steam within them until the efficiency of the condenser is reduced from 10 percent to 25 percent. It has been the custom heretofore to take hammers and pound the scale off the pipes when they are found to be scaley. This has been a dangerous and expensive method, for the pounders seldom struck the same blow; that is, some would not pound hard enough, while others would strike with force enough to crack the pipes and fittings, causing expensive repairs, loss of ammonia, and time. A discovery in cleaning and scaling condensers has been made recently; a pneumatic hammer can be used to advantage, and is a time and labor-saving device. A pneumatic hammer strikes rapid, uniform, light blows, which removes the scale instantly without danger of cracking pipes, fittings, or springing joints, and requires but one-fourth of the time to clean a condenser that the old hammering method does. This means that the condensers have to be closed down only a short time, and almost a normal output may be maintained during the condenser-cleaning operation. The air pump now employed in all modern plants is usually large enough to supply air for such a hammer.

MR. W. A. STADELMAN, eastern agent of the Wellman-Seaver-Morgan Company, Cleveland, O., who has been in charge of the eastern office at No. 42 Broadway, New York city, has been appointed general sales agent of the same company with headquarters at Cleveland, O. Mr. Fred. Stadelman has been appointed assistant manager of the New York office. Mr. Harry V. Croll, M.E., for the past eight years with the E. P. Allis Company, and their successors, Allis-Chalmers Company, Chicago, Ill., has resigned and accepted a position with the Wellman-Seaver-Morgan Company.

CUMMING'S PORTABLE RIVET FORGES are manufactured by David Cumming, 783 West Kinzie street, Chicago, Ill. The chief advantages claimed for these forges are lightness, strength, portability, and strong blast. They may be easily taken apart, the heaviest piece weighing only 28 pounds, and carried into such places as the fire room of a steamship or the top of a stand pipe or bridges. They have no chains, leather belts, bellows, or anything breakable or affected by the weather. The blower and pipe are easily detached, and may be used on flange fires for heating metals to shapes and for ventilating.

A SATISFACTORY BOILER COMPOUND.—The Bird-Archer Company, 209 Washington street, New York city, has received the following letter from the chief engineer of the transport *Sumner:* "After using your compound for somewhat over a year in the ships of which I have been chief engineer, I wish to inform you that it is the best article of its kind that I have ever seen. Before using your compound I was opposed to all articles of that class, but the fine working of yours has convinced me that there is merit in a good boiler compound. I left Hong Kong on my ship the 1st of August, and did not have an opportunity to open my boilers for inspection until I arrived in this port, December 14. On opening same I found them to be absolutely free from scale, oil and grease, absolutely no trace of salt incrustation, and, in fact, in excellent condition. I cannot speak too highly on the subject of your boiler compound, and willingly have you refer any person to me, and I can assure you I will give your compound the name it deserves, and that is A1. I have just put in a requisition for more of your material, and, in fact, as long as I am steamshipping, I never want to be without it. Very truly yours, Robert S. Paul, chief engineer U. S. A. T. *Sumner.*"

Trout propellers.—H. G. Trout, of the King Iron Works, 226 Ohio street, Buffalo, N. Y., reports that he is doing a rushing business in propeller wheels, many orders coming from old customers, showing that Trout wheels have given satisfaction. Among orders recently received is one from Mr. Lockwood, of South Norwalk, Conn., for his steamer *Lockwood*, the propeller being a duplicate of one he purchased two years ago. Mr. Lockwood reports, regarding a bronze wheel sent him some months since by the King Iron Works, that the wheel is satisfactory in every particular, and has greatly increased the speed of his boat.

Allen riveting machines.—John F. Allen, 370 Gerard avenue, New York city, who makes Allen portable pneumatic riveting machines, reports a good demand for these tools, with shipments during the month of June as follows: John Pirkl Iron Works, Brooklyn, N. Y.; Kalamazoo Foundry and Machine Company, Kalamazoo, Mich.; J. K. Petty & Company, Lebanon, Penn.; Cambria Steel Company, Johnstown, Penn.; Marava Construction Company, Chicago, Ill.; Dornfield, Kunert & Company, Watertown, Wis.; American Car and Foundry Company, Mephis, Tenn.; Standard Bridge Company, Red Oak, Ia.; Department of Marine and Fisheries, Sorel, Cal.; Hay Foundry and Machine Company, Newark, N. J.; Fenwick Frères & Company, Paris, France; Manning, Maxwell & Moore, New York city.

A patent controlled by the B. F. Sturtevant Company, Boston, Mass., has been issued for a special type of exhaust hood for grinding and polishing wheels. Its special feature consists of a receptacle to catch the particles of solid matter passing from the wheel, the suction being controlled so that it is not quite sufficient to draw them away, and these particles fall to the bottom and are there collected while the practically free air passes through a collector where the remainder of the dust is removed. The receptacle may be readily emptied when it becomes filled, and its use is planned to prevent excessive wear on the exhaust fan, piping, and collector. The hood is so designed with hinges and clips that the wheel may be readily removed or adjusted to fit the wheel as it wears to a small diameter. The outlet is connected to the exhaust fan and a shield, a swivel plate, and an extension slide may be adjusted so as to more fully enclose the wheel and prevent the discharge of particles into the room.

The Richardson Engineering Company, Hartford, Conn., reports sales of electric-lighting equipments for yachts as follows: A complete equipment to S. J. Matthews, of the Matthews Boat Company, for his 70-foot yacht. This equipment is to be one of the most complete that the company has turned out. It will include generator belted from the main engine, a fully-equipped switchboard, with all apparatus of full polished copper plate; a large enough set of storage batteries to run the lens mirror arc searchlight independent of the generator, the plant being so arranged that the current from the arc searchlight is turned from the generator while the engines are running at normal speed. When they are slowed down, running at half speed, the battery automatically picks up the searchlight, so that there is no break in the beam of the light. Also one of its standard 2-C equipments for the yacht *Onaway*, owned by Mr. C. T. Grantham, Hamilton, Ontario, Can. A steam set to W. G. Maxcy, Oshkosh, Wis. This steam set consists of a rotary engine direct connected to one of the company's standard dynamos, which is capable of furnishing twenty 16-candlepower lights, and occupies a floor space of about 14 by 24 inches. It includes lens mirror arc searchlight, switchboard, and entire installation material; the same size equipment for Lieutenant Hugh L. Willoughby, for his new 60-foot boat. The Richardson Engineering Company also reports a large number of sales of its smaller standard equipments, which are proving very popular, and states that its incandescent searchlight with a new form of reflector and incandescent bulb are giving wonderful results. This company also turns out compact direct-connected gasoline sets for plants of 30, 40, and 80 lights in single cylinder, and up to 300 lights in multiple cylinder, which are especially adapted to houseboats, sailing craft, automobile charging, and in any place where space is at a premium and lightness an advantage. The company reports having done twice as much work to date as it did during all last year.

A BRIEF HISTORY OF CRANE COMPANY, Chicago, Ill.—In the spring of 1855 Mr. R. T. Crane came to Chicago and opened a brass foundry. Work on the shop was completed July 3. Being anxious to see how the furnace and sand would work, and having some patterns ready, Mr. Crane took off a heat the next day, notwithstanding it was the Fourth of July. The sand used was found on the premises, and the first castings were couplings used in connecting lightning rods. Business prospects looking good, Mr. Crane sent for his brother, Charles S. Crane, who came in the fall, and was connected with the business until 1871. Shortly after his arrival they decided to go into the making and finishing of brass goods. A foot lathe was purchased, and the manufacture of brass engine trimmings begun. A few months later a room with power was rented, and the following spring a small three-story frame building was erected and equipped for power with a 6-horsepower portable engine. The next year jobbing in wrought-iron pipe and fittings and steam-warming work was taken up. Little business was done in the three years previous to the breaking out of the war because of the unsettled conditions prevailing. After the beginning of hostilities the demands of the government for all sorts of material created a boom in business generally. Soon the brass plant had to be enlarged, and the manufacture of brass globe valves, check valves, steam and gas cocks begun. An iron foundry was started, and the building of machinery and the making of a few articles belonging to the steam-fitting line was undertaken. About the same time a small butt-weld pipe mill, the first mill west of Pittsburg, was built on ground where the Crane Company still has a pipe mill. In the same year (1864) the property where the present brass department is located, known as No. 10 North Jefferson street, was purchased, and the first malleable-iron foundry outside of the eastern states started. This foundry was on the second floor, and is said to be the first instance of a foundry being placed above the ground floor. The manufacture of both malleable- and cast-iron fittings was commenced. The fitting industry was then in its infancy in this country. Most of the fittings used were wrought-iron fittings imported from England. Not more than six or seven concerns were in the business in the United States, and their total output was small. About this time the three-way tapping machine was invented. Two, with some original improvements, were built by the Crane Company, and installed in their shops, one for tapping 3-4-inch and smaller, and the other for tapping 1 to 2 inches. The few fittings required above two inches were threaded in a lathe. In connection with the fitting business the company early took up the manufacture of dies and die plates. In 1865 the business was incorporated, and the name changed from R. T. Crane & Brother to the Northwestern Manufacturing Company. This name was retained until 1872, when the title Crane Brothers' Manufacturing Company was adopted, which was changed in 1890 to Crane Company. By 1870 the business had grown so that further extensions were necessary. The land west of the property at No. 10 North Jefferson street was purchased and a building erected thereon. Fortunately the company escaped the big fire of 1871, and the large increase that had recently been made in facilities enabled the company to take advantage of the heavy demand for goods created in the re-building of the city. In 1881 another pipe mill was erected on property purchased on West 12th place, where there were excellent railroad facilities. One lap-weld and two butt-weld furnaces were erected. Although the Crane Company was concentrating upon the manufacture of valves and fittings, the continued growth of the business demanded extensive additions in 1891, 1899, 1900, 1902, 1903, and this year a five-story modern office building has been erected. Not only has there been an immense increase in the floor space used for manufacturing purposes, but all departments have been equipped with the latest improved machinery, much of which has been designed and built by the company. A sketch of the Crane Company would not be complete without a description of the growth of its branch-house system, which, by ensuring large and steady sales, enabled the company to devote its resources and energies to a single line of manufacture with the consequent result of being able to use highly specialized automatic machinery. The first Crane Company branch was established in 1886 at Omaha. One year later branches were opened in Los Angeles and Kansas City. The success of these branches led to the determination to start others, and make branch houses a permanent and important feature of the business. The branch houses carry stocks enabling the customer to get goods promptly and be assured of receiving uniform articles. In 1890 the first eastern branch began business in Philadelphia. Other branches have been established in the following cities: San Francisco, 1891; Minneapolis, 1892; St. Paul, 1893; New York, 1894; Portland, Ore., 1894; Duluth, 1894; Sioux City, 1897; Oakland, Cal., 1898; Cincinnati, 1899; St. Louis, 1899; Salt Lake City, 1902; Seattle, 1902; Watertown, S. D., 1903; Chanute, Kan., 1903; Independence, Kan., 1904; Spokane, 1904; Fargo, N. D., 1904; Baltimore, 1904; Memphis, 1904; Dallas, 1904; and Birmingham, 1905. All the branches except New York carry complete stocks of plumbing supplies. The Chicago sales department, conducted in connection with the general offices, does not handle plumbing material. While no special effort has been made to create a demand for Crane goods outside of the United States and their possessions, for the reason that the capacity of the company has been fully taxed in taking care of domestic demands, nevertheless they are sold in considerable quantities in Canada, Great Britain, Denmark, Mexico, South America, South Africa, Australia, Japan, China, and Russia, and in smaller quantities in all countries of the world. The company was awarded the only gold medal given at the Paris Exhibition, 1900, for exhibits of valves and fittings. Recently a European sales office and showroom has been opened at No. 95 Queen Victoria street, London, E. C.

AN EFFICIENT AUXILIARY ENGINE.—The B. F. Sturtevant Company, Hyde Park, Mass., manufacturer of fans, blowers, and marine and stationary engines, state that "the rigid specifications drawn by the United States navy department for auxiliary engines required in the equipment of vessels of recent construction, have done much to improve their general standard of efficiency. It is therefore unusual to find that even these exceptional requirements have been improved upon. Such, however, is true in the case of recent designs of vertical cross-compound engines built by us for direct connected generator driving. These engines have shown upon an economy test, a consumption of steam per horsepower four pounds less than that demanded by the specifications. This result is characteristic of a line of engines we are building to develop from 25 to 150 H. P."

MARINE ENGINEERING
EMPLOYMENT BUREAU

Full information regarding the purposes of this Bureau, together with instructions regarding registration, etc., furnished upon application to MARINE ENGINEERING Employment Bureau, 17 Battery Place, New York city.

All correspondence, concerning either vacancies or situations wanted, is strictly confidential.

MEN SEEKING POSITIONS

We have applications registered for positions as follows, and the references of each applicant have been carefully investigated:

ASSISTANT OR SUPERINTENDING ENGINEER to shipping concern or factory seeks position; is 30 years old, married, and has had several years experience at sea as chief engineer. Application No. 100.

BOILER-MAKER FOREMAN seeks position. Is at present foreman of railroad shops and has charge of nearly one hundred men; has had twelve years' experience as foreman; posted in the latest boiler practice; has best references as to ability and character; is 38 years old. Application No. 73.

BOILER-SHOP FOREMAN. Age 35; single; many years' experience in Navy Yard and leading shipyards. Application No. 59.

BOILER-SHOP FOREMAN. Age 37; single; 16 years' experience in boiler-shop work. Application No. 47.

CHIEF OR ASSISTANT CHIEF DRAFTSMAN—ENGINE. Age 33; married; has had sea experience and thirteen years as leading and chief draftsman of private and government shipyards. Application No. 25.

CHIEF DRAFTSMAN OR SUPERINTENDING ENGINEER seeks position. Has had extensive experience in several of the best known shipyards, and can furnish the best of references. Application No. 81.

CHIEF DRAFTSMAN OR CHECKER seeks position; is 36 years old; married; was with the Carnegie Steel Company for about three years; later with the National Steel Company, and with the American Bridge Company. Application No. 79.

DESIGNER, EXPERIENCED, of dredges and other types of vessels, seeks position; is 28 years old; has had 10 years of experience in Great Britain and this country in leading shipyards. Application No. 82.

DESIGNER AND DRAFTSMAN. Has had many years' experience in launch and river boat work. Designed some of the fastest river boats in the country. Application No. 61.

DRAFTSMAN. Position in a drafting office desired by a young man just finishing his course in naval architecture. Application No. 108.

DRAFTSMAN seeks position; has had long experience in designing, including main and auxiliary engines for torpedo-boat destroyers for the British Admiralty, and some of the best suction dredges that have been built in Great Britain. Best of references in this country. Application No. 111.

DRAFTSMAN, ENGINE AND BOILER. Age 30; unmarried; has Danish marine license; technical school graduate. Application No. 57.

DRAFTSMAN—HULL. Age 20; single; experienced in architectural work, but prefers marine drafting. Application No. 51.

DRAFTSMAN—HULL, OR INSPECTOR. Age 37; married; had experience both in government yards and private yards. Application No. 30.

DRAFTSMAN—HULL. Age 22; single; born in Norway; studied Technical schools in Norway and Germany; experience as draftsman, also as shipfitter. Application No. 31.

DRAFTSMAN—HULL AND ENGINE. Age 26; single; graduated Webb Academy; has had four years' experience in navy yard work; desires connection with private shipyard. Application No. 41.

DRAFTSMAN—ENGINE, STEAM OR GAS. Forty-three years old; single; born in Germany; has had extensive experience in designing and drafting; has had sea experience. Application No. 32.

DRAFTSMAN, ESTIMATING, seeks position; age 30; single; graduate of the Virginia Polytechnic Institute; has had several years' experience in well-known shipyards. Application No. 110.

DRAFTSMAN—MARINE. Age 34; married; accustomed to intricate drafting work. Application No. 50.

DRAFTSMAN, MECHANICAL, capable of designing and computing, age 31, seeks position in connection with hull and engine work. Has had experience in government work; also in well-known shipyard. Application No. 114.

DREDGE DESIGNER seeks position; has had 10 years' experience in designing and building dredges of all kinds. Application No. 99.

DREDGE OR SHIPBUILDER who has had 20 years of experience in calculating and designing in connection with dredges and other vessels seeks position. Application No. 83.

GANG FOREMAN IN ERECTING SHOP OR FITTING UP ENGINES IN SHIPS. Age 37; married; has been with present employers 15 years. Application No. 26.

GAS ENGINE DRAFTSMAN seeks position; is 27 years old; married; technical-school graduate; has had several years' sea experience, as well as a number of years of special work in connection with gas engines; has had experience in building these engines up to 1,500 horsepower; thoroughly posted on all office detail and laying out work. Application No. 97.

GAS ENGINE OPERATOR. Age 28; single; born in Germany; 7 years' experience; understands naphtha engines of Gas Engine and Power Co. thoroughly. Application No. 48.

HULL SUPERINTENDENT. Age 42; married; born and learned trade in Scotland, studied at Glasgow School of Naval Architecture, experienced as foreman; surveyor and hull superintendent. Application No. 27.

LAUNCH AND YACHT SUPERINTENDENT AND DESIGNER. Age 34; married; has had about fifteen years' experience in some of the best known launch and yacht building establishments in the country. Application No. 62.

LEADING DRAFTSMAN OR SUPERINTENDING ENGINEERING FOR STEAMSHIP LINE. Age 34; married; studied Massachusetts Institute of Technology; 11 years' experience in drafting and other marine work. Application No. 53.

LOFTSMAN. Age 33; single; has had eight years' experience as loftsman, foreman, and draftsman. Application No. 44.

MARINE MAN, EXPERIENCED, with excellent recommendations seeks outside position in shipyard or to represent some manufacturing concern or launch builder; is 39 years old and single. Application No. 78.

MASTER OF STEAM YACHT. Age 37; married; born in Norway; has license as master and pilot on ocean steamer; has commanded several well-known yachts. Application No. 40.

MASTER OF SHIP OR YACHT. Age 40; 7 years' experience; has first class master's license for all ocean and coastwise steamers and pilot for most harbors on the coast. Application No. 39.

MASTER OR PIER SUPERINTENDENT. Age 38; has spent whole life at sea and has British Extra and American master's certificate; pilot New York and San Francisco; experience in handling men and cargoes. Application No. 35.

MASTER AND PILOT. Age 44; single; 11 years' experience; has license for 500 tons as master and pilot ocean and inland for New York, New Haven, and New London districts. Application No. 20.

MASTER OR PILOT seeks position, preferably on a houseboat. Has had 43 years' sea experience in all parts of the world. Is well acquainted with the inside route from New York to Florida, and with all the waters of Florida and adjacent lines. Best of references. Application No. 115.

OILER. Who has had experience on one of the well-known coastwise lines seeks position. Application No. 64.

OILER seeks position to learn marine engineering; is single; 22 years old; well educated and has had considerable mechanical experience. Application No. 77.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line or fraction thereof, for the first insertion, and twenty-five cents per line for each subsequent insertion. Lines average ten words each. The heading counts as a line, as does also the address.

DRAFTSMEN WANTED.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur. Wants men now employed. Give full experience and reason for changing. Shop experience great advantage. All letters acknowledged and held confidential. M. M., care MARINE ENGINEERING, 17 Battery Place, New York.

POSITION WANTED.

Designing Marine Engineer, 41 years of age, married, desires to change position as Chief Engineer or Chief Draftsman. Fifteen years with present employers. Active, energetic, capable of handling a large number of men. Excellent references and good reasons given for wishing to change. Address ENGINEER, care MARINE ENGINEERING, 17 Battery Place, New York.

THE ROE STEPHENS MANUFACTURING COMPANY, Detroit, Mich., has bought the plant of the Michigan Brass and Iron Works, Detroit.

RACINE BOATS IN MEXICO.—The Tampico Rowing Club, Tampico, Mexico, has ordered two 6-oar rowboats from the Racine Boat Manufacturing Company, Muskegon, Mich.

THE MOSHER WATER TUBE BOILER COMPANY, I Broadway, New York city, has been incorporated with a capital stock of $1,000,000. The incorporators are Charles D. Mosher, 1 Broadway, New York city; Gardiner C. Sims, Providence, R. I., and Arthur S. Beves, Glenridge, N. J.

DIMENSION SHEETS, bolts and bars, sheathing, slating, and boat nails, condenser and supporting plates, piston and pumping rods, etc., are made by the Taunton-New Bedford Copper Company, New Bedford, Mass. The company claims that its product is unequaled for high-class marine work.

SLOW-SPEED MOTOR DRIVE.—Bulletin No. 44, issued by the Northern Electrical Manufacturing Company, Madison, Wis., illustrates applications of geared motors in industrial plants. The motors are compact and self-contained, accomplishing slow speed without the necessity of employing designs for slow armature speed. This arrangement is said to secure a motor of low cost for operating slow-speed machines.

ASBESTOS PACKING FOR SUPERHEATED STEAM.—The H. W. Johns-Manville Company, 100 William street, New York city, states regarding its asbestos "Vulcabeston" packing, that it is furnished in sheet, moulded, and special ring forms for joint; moulded concave and convex rings for movable rods and valve stems; twisted and braided rope form for stop valves; and special extra-graphite forms for work on steam turbines. The company states that "Vulcabeston" is used in nearly every large power plant in the United States where superheated steam has been installed. A pamphlet describing "Vulcabeston" will be sent upon application.

ALBANY GREASE SPINDLE CUP.—This cup, which is made by Adam Cook's Sons, 313 West street, New York city, may be readily attached to the bearing by any machine. A hole through the cap and brass is bored, of sufficient size to allow the outside tube of the cup to enter the inside spindle coming into contact with the shaft. The outside tube, being shorter, will clear the shaft by from one-fourth to three-eighths of an inch. The inside spindle is then removed, the cup filled and the spindle replaced, when the apparatus is ready for use. It is claimed that the most obstinate bearing will yield when Albany grease is used, whether on slow or fast running machinery.

ANTI-FOULING PAINT.—The Hertzog Paint and Varnish Company, 627 Cherry street, Philadelphia, Pa., has received the following letter from Captain N. B. Watson, of the yacht *Constellation*, Beverly, Mass.: "May 24, I received a half gallon of your red anti-fouling paint as a sample with my order of cement paint, and applied it to the rudder of yacht *Constellation*. On Sept. 29 we hauled out and after being on all season, I found your paint clean and smooth. The paint looked good and fresh, not having cracked or peeled off. In my experience, what little I have used of your red paint has given the best satisfaction of any I have ever used. There is nothing I have ever used as good for a steel vessel, as Hertzog's cement paint to prevent rusting. I have used it on the yacht *Constellation* for the last twelve years."

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

12 West 31st Street, New York.

President, FRANCIS T. BOWLES.
Secretary-Treasurer, W. J. BAXTER.
Executive Committee, LEWIS NIXON, EDWIN A. STEVENS, HARRINGTON PUTNAM, STEVENSON TAYLOR. *Ex-officio*, FRANCIS T. BOWLES, W. J. BAXTER.

AMERICAN SOCIETY OF NAVAL ENGINEERS.

Navy Department, Washington, D. C.

President, Commander A. F. DIXON, U.S.N.
Secretary-Treasurer, Lieutenant CHARLES K. MALLORY, U.S.N. (retired.)
Council, Captain GEORGE W. BAIRD, U.S.N.; Commander J. K. BARTON, U.S.N.; Commander W. M. PARKS, U.S.N.

MARINE ENGINEERS' BENEFICIAL ASSOCIATION.

National President, FRANK A. JONES, 1959 Eddy St., San Francisco, Cal.
Vice-President, CHARLES W. ROBINSON, 908 G. St., N. W., Washington, D. C.
Second Vice-President, EVANS I. JENKINS, 153 Clinton St., Cleveland, Ohio.
Secretary, GEORGE A. GRUBB, 1318 Wolfram St., Lake View, Chicago.
Treasurer, ALBERT L. JONES, 289 Champlain St., Detroit, Mich.
Advisory Board, WILLIAM F. YATES, 120 Liberty St., New York city; GEORGE F. KEATING, 74 Webster St., East Boston, Mass.; W. D. BLAICHER, 10 Exchange St., Buffalo, N. Y.

ADDRESSES OF CORRESPONDING SECRETARIES.

No. 1, W. D. Blaicher, 10 Exchange St., Buffalo, N. Y.
" 2, Wm. Kelly, 11 Wall St., Cleveland, O.
" 3, A. L. Jones, 289 Champlain St., Detroit, Mich.
" 4, James A. Macauley, 5802 Indiana Ave., Chicago, Ill.
" 5, Otto Boettger, 1035 E. Hopkins Ave., Baltimore, Md.
" 6, Wm. Arste, 322 Pine St., St. Louis, Mo.
" 7, Wm. T. McElwee, Box 1556, Portland, Me.
" 9, Wm. Bridges, 784 1-2 12th St., Milwaukee, Wis.
" 13, John G. Paulding, 1746 Tulip St., Philadelphia, Pa.
" 14, Joseph F. Dumas, 403 Dauphin St., Mobile, Ala.
" 15, R. L. Skinner, 622 Louisa St., New Orleans, La.
" 17, Jas. D. Robinson, 6th and Columbia Sts., Newport, Ky.
" 18, Wm. Hurst, 715 Walnut St., Cairo, Ill.
" 20, Jos. B. Barry, 206 Keel St., Memphis, Tenn.
" 21, J. H. Foley, 206 N. Mulberry St., Vicksburg, Miss.
" 23, Wm. R. Lewis, 213 E. Front St., Jeffersonville, Ind.
" 24, Hugh L. Edwards, 511 Washington St., Paducah, Ky.
" 26, T. H. Kirkbridge, 228 Bond St., Evansville, Ind.
" 27, L. C. Schwall, 598 S. Madison St., Bay City, Mich.
" 29, James R. Sutherland, Charleston, W. Va.
" 30, E. R. Humphrey, 21 State St., Pittsburg, Pa.
" 33, James J. Waters, 21-24 State St., New York, N. Y.
" 35, William M. Coombs, 36 East St., San Francisco, Cal.
" 36, Jos. Thomas, 57 Sea St., New Haven, Conn.
" 37, John B. Bender, 1215 Evesham Ave., Toledo, Ohio.
" 38, C. H. Wolford, 73 Starr Boyd Bldg., Seattle, Wash.
" 39, Frank Feeney, 460 E. 12th St., Erie, Pa.
" 40, Chas. Drouet, 1003 Ave. I, Galveston, Tex.
" 41, W. H. Marshall, 343 Holladay St., Portland, Ore.
" 42, Jas. Manning, 802 E. Duval St., Jacksonville, Fla.
" 43, A. J. Wilson, 1327 La Peer Ave., Port Huron, Mich.
" 44, Chas. J. Sullivan, 480 1st St., Manistee, Mich.
" 45, W. L. Salter, care O. S. S. Co., Savannah, Ga.
" 46, D. W. Farrell, Clayton, N. Y.
" 47, J. R. Cook, Sault Ste. Marie, Mich.
" 48, Alfred Hegemer, 140 E. Park St., Sandusky, O.
" 51, H. S. Connell, 12 Ranson St., Muskegon, Mich.
" 53, Harry Stone, Box 445, Marine City, Mich.
" 55, Archie Stalker, Box 883, Cheboygan, Mich.
" 57, E. B. Meeker, 71 Abeel St., Kingston, N. Y.
" 58, E. Capers Haselden, Box 31, Georgetown, S. C.
" 59, George F. Keating, 74 Webster St., E. Boston, Mass.
" 62, N. S. Lawrence, 30 Connecticut Ave., New London, Conn.
" 63, M. J. Burke, 152 Sheridan Ave., Albany, N. Y.
" 65, W. C. Palmer, care Consumers' Coal Co., Charleston, S. C.
" 67, James K. Dole, Saugatuck, Mich.
" 70, Charles T. Smith, 665 Commercial St., Astoria, Ore.
" 72, Wm. T. Findlay, 130 W. Bridge St., Oswego, N. Y.
" 73, E. M. Donahue, 1308 Cherry St., Green Bay, Wis.
" 75, Wm. D. Hemenway, Alexandria Bay, N. Y.
" 76, Orson Vanderhoef, Grand Haven, Mich.
" 77, John P. Hall, 1215 Huron St., Manitowac, Wis.
" 78, J. P. Burg, 2722 Minnesota Ave., Duluth, Minn.
" 80, Edward S. Welch, 338 Hamilton St., Albany, N. Y.
" 81, Jas. L. Sweeney, 206 E. Sarragosa St., Pensacola, Fla.
" 82, Fred H. Gowell, 427 Middle St., Bath, Me.
" 85, John A. Packard, 623 Merchant St., Alpena, Mich.
" 86, Sherman A. Smith, 737 Menekaunee Ave., Marinetta, Wis.
" 87, George B. Milne, 809 Fourth St., Detroit, Mich.
" 88, C. O. Chapman, S. B. Canal, Sturgeon Bay, Wis.
" 89, Geo. E. Willard, 4 Isabella St., Ogdensburg, N. Y.
" 91, A. L. McLaren, 130 W. Walnut St., Ashtabula, O.
" 92, Jos. D. Budd, Box 50, Sta. I, Saginaw, W. S., Mich.
" 93, W. J. Cook, 2220 G. St., N. W., Washington, D. C.
" 94, George R. Jones, Box 222, Washington, N. C.
" 95, P. J. McMahon, Box 199, Key West, Fla.
" 98, C. N. Vosburg, 6323 Patton St., New Orleans, La.
" 100, H. F. Mocine, Honolulu, H. I.
" 101, J. K. Cotton, Box 765, Norfolk, Va.
" 102, Fred. W. Linsemeyer, 210 Clinton St., South Haven, Mich.
" 103, A. E. Pittman, Box 378, New Bern, N. C.

TRADE PUBLICATIONS.

Air Power, published monthly by the Rand Drill Company, 11 Broadway, New York city, always contains much useful information for the user of pneumatic tools and compressed air. We understand that all applicants mentioning MARINE ENGINEERING will be put on the free mailing list.

Gas producers are illustrated and described in a 50-page catalogue issued by the Morgan Construction Company, Worcester, Mass. The catalogue states: "The Morgan continuous gas producer has been developed to secure the greatest possible efficiency and most perfect uniformity and continuity in the manufacture of producer gas." Any person interested in the subject of producer gas should send for this publication, a free copy of which will be forwarded upon request.

"An ounce of prevention is worth a pound of cure," says the Reliance Gauge Column Company, Cleveland, O., in a leaflet describing its safety water columns. The advantages claimed for this company's water columns "are not found in the mere fact that they whistle in any emergency and thus obviate disaster. They cause the fireman to watch the water carefully, in order to keep the whistle quiet and thus make a good record. The results are: Steady water, steady steam pressure, dry steam, steady power, less expansion and contraction, longer life for the boilers, less repairs, less stoppage, less fuel wasted, no leaky tubes, no burned crown sheets, no boiler explosions."

Steam turbines are described and illustrated in bulletin No. 10 of the De Laval Steam Turbine Company, Trenton, N. J. The bulletin states: "The works of the De Laval Steam Turbine Company were built in 1901 and occupy a unique position among the machine shops of the country in that they were the first shops in America to be devoted exclusively to the manufacture of steam turbines. The buildings embody the most modern ideas, and in design follow out certain desirable features of construction of the parent shops at Stockholm, Sweden, where the original De Laval Company is located. Besides the American and Swedish companies there are also the French De Laval Company (Societe de Laval), located at Paris, and the English Company (Greenwood & Batley), at Leeds, England, so that the American works are one of a system of factories engaged in the manufacture of steam turbines and turbine machinery, under the De Laval patents, in different parts of the world."

"A Condensed Talk about Condensers," is the subject of an illustrated 32-page pamphlet issued by Williamson Bros. Company, Aramingo avenue and Cumberland street, Philadelphia, Pa. The introduction states: "The value of condensing is so well understood that we deem it superfluous to enter into a discussion of this phase of the subject. Those who may wish to do so will find on the last pages of this booklet a series of tables which will prove of material assistance. The introduction and demonstrated commercial success of the cooling tower in places where it is impossible to obtain an ample supply of cooling water for condensing purposes, has affirmatively answered the question every manager of a plant asks, i.e., can we run condensing? This leads us to consider the degree of vacuum to be obtained on the engine or turbine, and the most efficient apparatus for maintaining it. As a general rule, a vacuum from one to two pounds of absolute is the most desirable for reciprocating engines, while for steam turbines, it will usually pay to get the highest vacuum obtainable. Whether the vacuum shall be procured with a surface or jet condenser, whether the apparatus thermo-dynamically, the least expensive to operate, or one having the lowest first cost and maintenance charges shall be installed, are problems that can best be solved by each plant. To this end, we solicit your correspondence." Surface condensers, jet condensers, ejector condensers, barometric tube condensers, turbine condensers, cooling towers, evaporators, and feed water heaters, are described and illustrated in the pamphlet. Williamson Bros. Company also makes steam steering engines, electric steering equipment, tiller steering gears, telemotors, electric hoists, hoisting winches, etc. A free copy of this booklet will be forwarded upon application to the company.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS.

314 Madison Avenue, New York City.

President, JOHN J. AMORY.
First Vice-President, H. A. LOZIER, JR.
Second Vice-President, CHARLES A. STRELINGER.
Third Vice-President, HENRY R. SUTPHEN.
Treasurer, J. S. BUNTING.
Secretary, HUGH S. GAMBEL.
Executive Committee, JOHN J. AMORY, Chairman: 1908, J. B. SMALLEY, JAMES CRAIG, JR., C. L. SNYDER, EUGENE A. RIOTTE, A. MASSENAT. 1907, JOHN J. AMORY, H. A. LOZIER, JR., J. S. BUNTING, H. N. WHITTELSEY, CHARLES A. STRELINGER. 1906, S. J. MATTHEWS, A. SNYDER, H. H. BRAUTIGAM, ALBERT E. ELDRIDGE, HENRY R. SUTPHEN.

The Marine Launch Igniting and Lighting Company, Watkins, N. Y., is distributing literature describing its automatic switches, ammeters, searchlights, etc.

"A Short Story of Nathan Reed," is the title of the latest brief biography issued by Wyman & Gordon, Worcester, Mass., manufacturers of drop forgings.

Compression yoke riveters are described in illustrated catalogue No. 3, issued by the Hanna Engineering Works, 820 Elston avenue, Chicago, Ill. These riveters are made especially for shipbuilding, boiler shop and other structural iron and steel construction.

"An Electrified Railway Shop, Described by Its Mechanical Engineer," is the title of bulletin No. 58, issued by the Crocker-Wheeler Company, Ampere, N. J., manufacturers and electrical engineers.

Exhaust fans are the subject of illustrated catalogue No. 180, issued by the American Blower Company, Detroit, Mich. This company has recently received a large order from the National Tube Company, Pittsburg, Pa., for the complete heating apparatus for the latter company's five new butt weld mills at Lorain, O.

The July and August stock list, issued by the Scully Steel and Iron Company, Chicago, Ill., will be sent free upon application. This stock list comprises 146 pages, several hundred illustrations, and lists almost everything a boiler maker or iron worker might want from angles to "Z" bars.

"Northern" spherical machines are illustrated and described in bulletin No. 50, issued by the Northern Electrical Manufacturing Company, Madison, Wis. The bulletin shows standard dynamos and motors and the modifications of these frames, illustrating Northern machines and their applications in machine shops, industrial plants, etc. A free copy of this bulletin will be forwarded to readers of MARINE ENGINEERING, upon request.

"The Picture Book," is the title of an illustrated booklet issued by the Kingsford Foundry and Machine Works, Oswego, N. Y., describing the company's many styles and sizes of pumps. Among those illustrated are turbine pumps of various kinds, side-section pumps of several types, a large number of motor driven pumps, hydraulic dredging pumps, suction pumps of all kinds, and, in fact, pumps for almost every purpose. The company is prepared to furnish turbine pumps of the horizontal or vertical types, for any head or any quantity and guarantee results.

"A. B. C." electric disk fans are described and illustrated in bulletin 66, issued by the American Blower Company, Detroit, Mich. This bulletin states: "The American Blower Company's disk fan and the Westinghouse motor are recognized as pre-eminently the most efficient in their respective fields, and their combination can only result in an outfit of undoubted superiority. Before shipment the motor is run under load and tested for temperature, commutation and regulation, each part having been previously submitted to a thorough system of tests and inspection while under construction."

Rotary planing machines are described in illustrated catalogue No. 41, issued by the Newton Machine Tool Works, Philadelphia, Pa. These machines are made of one general design, having cutter heads from 26 inches to 100 inches in diameter over tools, and may be either plain, portable, on circular sub-base, or mounted on long bed, to face off both ends of work simultaneously. "The cutter head is driven through gearing by a pinion meshing into an internal gear on the cutterhead. Saddle movement is by means of a spiral pinion and rack, having four changes of geared feed and power quick traverse in either direction. Our method of feeding carriage, in addition to giving a smooth and even motion, does away with the long feed screw, which is frequently a source of trouble owing to its sagging and binding."

The Tabor indicator, manufactured by the Ashcroft Manufacturing Company, 85 Liberty street, New York city, is described and illustrated in a 32-page catalogue the company is distributing. Special attention is called to the parallel movement and pressure spring parts of the Tabor indicator: "The parallel movement and pressure spring are parts of an indicator to which all makers have devoted special attention. The parallel movement of the Tabor indicators is really the only one in which the pencil point will travel in an exact parallel to the movement of the indicator piston through any required distance. With the Tabor indicator parallel movement it is not necessary to limit the height of the drum and card to prevent a curve at the extremities of the lines produced by the so-called parallel movements very often employed. Another strong point of the Tabor movement is the exact maintenance of the ratio of the movement of the pencil point to the movement of the piston during every part of the stroke."

The annual report of Webb's Academy and Home for Shipbuilders, Fordham Heights, New York, has just been issued. The academy was founded in 1889 by William Henry Webb, for the purpose of furnishing any young man, a citizen of the United States, of good character, who may upon examination prove competent, a gratuitous education in the art of ship and marine engine building, both theoretical and practical, together with board, lodging and necessary implements and materials while obtaining such education, and also to afford free relief and support to aged, indigent or unfortunate men who have been engaged in building vessels, or marine engines, in any section of the United States, together with the wives or widows of such persons.

The joiners' and shipbuilders' edition of the catalogue issued by the Berlin Machine Works, Beloit, Wis., is a complete and beautifully illustrated volume of 90 pages, which will be sent free upon application to those mentioning Marine Engineering. The company's aim in preparing this catalogue has been to give information which will meet the special requirements of shipbuilders and joiners who are in the market for woodworking tools. The catalogue states: "We are building tools adapted to the needs of the present. Many of them differ radically in construction from the woodworking machines of the past, and all changes have been made after a careful study of existing conditions."

Graphite for gas engines.—The August issue of *Graphite*, published by the Joseph Dixon Crucible Company, Jersey City, N. J., contains the following letter from Albert Albaugh, Meadville, Pa., addressed to the Dixon Company: "I wish to thank you for your booklets, which contained the information I desired, and which also gave me some pointers where to use Dixon's flake graphite to advantage in other places. Last week we tested a 250-horsepower four-cylinder gas engine and found Dixon's graphite to be just the thing on the testing floor. We used it in the cylinders and on all bearings. It gave the best of satisfaction, leaving the cylinders with a perfect gloss after the test." Any of the Dixon publications regarding graphite and its uses will be sent free upon request.

Reducing valves are described and illustrated in a 58-page catalogue issued by the Mason Regulator Company, Boston, Mass. The catalogue states: "The splendid reputation of the Mason reducing valves is not the result of an accident, but the outcome of twenty-two years of persistent effort backed by large capital and superior manufacturing facilities. They hold the first place to-day because their merits entitle them to that position. No other valves work so accurately, wear so long, nor accomplish their purpose so fully as the Mason. Once installed they are always demanded thereafter, and thousands of manufacturers absolutely depend on these valves working in many critical locations, and find them satisfactory. The Mason reducing valves were designed by an expert engineer of long and varied experience and having a full and complete knowledge of the requirements of a satisfactory valve. The aim of the designer to produce a simple practical self-contained reducing valve of the best material and workmanship has been fully realized. Neither time nor money has been spared to make them the most perfect valves in the world, and thousands of users have attested in written testimonials our success. We shall be pleased to hear from persons who have some difficult or peculiar reducing problems to solve, as we can often suggest an easy, reliable, and economical solution. The long and varied experience of our engineers is at the service of all of our patrons. Always write us freely, and be assured we shall answer promptly and fully."

BUSINESS NOTES.

C. LEE COOK MANUFACTURING COMPANY, Louisville, Ky., has succeeded to the business of Mr. C. Lee Cook, and will continue to manufacture metallic, rod and Corliss valve steam packing.

CRANE COMPANY, Chicago, Ill., has removed its general offices and sales departments to its new office building at 519 South Canal street, Chicago. The company was located at No. 10 North Jefferson street continuously since 1864, and a branch of its city sales department will be continued at the latter address. In the new building the company has five floors of offices, giving it ample space for the proper transaction of business.

A FEATURE OF THE BOILER PLANT of the Garlock-Frazee Laundry Company, Cleveland, O., is the induced mechanical draft apparatus applied to four Babcock and Wilcox boilers, aggregating about 1,000 rated horsepower. This apparatus, furnished by the B. F. Sturtevant Company, Boston, Mass., consists of an 8-foot blast wheel, driven by a direct-connected 7 by 10½ horizontal engine; the steam pressure being maintained practically constant by means of a Foster regulating valve. The boilers are equipped with chain grates and the apparatus is designed to have draft sufficient to burn the general run of Pittsburg slack.

A NEW INCORPORATION.—The Mianus Motor Works, Mianus, Connecticut, has been incorporated with a paid up capital stock of $100,000. On January 1, 1905, they purchased the business of the Brooklyn Railway Supply Company, Mianus, Conn., and have taken over all its assets and liabilities. The Mianus Motor Works propose to conduct the business formerly carried on by the Brooklyn Railway Supply Company on a more extensive scale with increased capital. The officers of the company are as follows: President, George Gray; Vice-President, Frederick A. Hubbard; Secretary, A. P. Avery; Treasurer, Charles B. Allyn.

YACHT SAIL MAKERS.—Wilson & Silsby, Rowe's Wharf, Boston, Mass., call attention to the fact that they make a specialty of sails for racing yachts. They have furnished sails for the following well-known yachts: *Constitution, Defender, Volunteer, Jubilee, Colonia, Independence, Ailsa, Navahoe, Weetamoe, Uncle Sam, Effort, Calypso, Flirt, Ariadne, Quissetta, Constance, Intrepid, Vergemere, Resolute, Chanticleer, Senta, Snapper, Raider, Little Haste, Sally VII, Chloris,* and many others. They have on hand constantly high grade sail cloth manufactured especially for them.

SOMETHING NEW IN TOOL STEEL.—The Sheffield Steelmakers, Ltd., Sheffield, England, are putting something new on the market in the way of special water hardening tool steel, designed especially for trade requiring keen and long lasting cutting implements, such as machine knives and all sorts of keen edged tools. Tests which have been made of this steel have shown most excellent results, according to a very complimentary article published in the *Sheffield Daily Independent,* which gives a long description of this steel. Full information regarding it, together with prices, etc., can be had by applying direct to the makers.

A WELL-KNOWN SUBMARINE COMPOUND.—Samuel J. Williams & Co., 70 Broad street, New York city, report that they have been making anti-corosive and anti-fouling compounds for iron and steel vessels for sixty-one years. The Williams compound is recognized as being of especial value in tropical waters. It is used by the United States navy and revenue cutter service, by the Old Dominion line, the Red D line, by the Pacific Mail Steamship Company, and by many other lines. The manufacturers have numerous agents and can give estimates on docking and painting at almost any dock in the world.

THE B. F. STURTEVANT COMPANY, Hyde Park, Mass., reports the following orders recently received: Marine generating sets for F. B. Polson's and Timothy Eaton's yachts building at Toronto, Canada, for the tug *Menasket*, and through the Portsmouth navy yard, for United States navy shops; heating and ventilating systems for the Fall River Iron Works Company, Fall River, Mass.; Nashua Manufacturing Company, Nashua, N. H.; Bemis Bag Company, Kansas City, Mo.; Fore River Shipbuilding Company, Quincy, Mass.; Lewis Crossett, North Abbington, Mass., and Trenton Brass and Machine Company, Trenton, N. J.

CRANE COMPANY'S FIFTIETH ANNIVERSARY.—Crane Company, Chicago, Ill., celebrated its fiftieth anniversary July 4. All of the company's branch house managers took part in the celebration. Monday the branch house managers went through the Crane Company's factories. In the evening they were given a dinner and taken to the "White City." Tuesday morning the managers went to Lake Geneva, Wis., where they were entertained by Mr. R. T. Crane at his summer residence on that and the following day. Thursday, July 6, the company gave to all its employees and their families a picnic at Northwestern Park. About 10,000 people attended this picnic.

WHAT IS CLAIMED TO BE the largest searchlight in the world has been built at Berlin, Germany, by Siemens & Schubert for the Russian government. It is of 316,000,000 candlepower.

THE ARMSTRONG CORK COMPANY, Pittsburg, Pa., has opened a store and office in Cincinnati, O., under the management of Mr. J. L. Hawkins, and will carry there a full line of corks and cork products.

A NEW SHIPBUILDING COMPANY.—The business of T. S. Marvel, Newburg, N. Y., has been transferred to T. S. Marvel Shipbuilding Company, which assumes all of Mr. Marvel's obligations, and will continue the business of ship and engine building.

A SATISFACTORY FINANCIAL STATEMENT.—The statement of earnings for the six months ending June 30, issued by the Chicago Pneumatic Tool Company, Chicago, Ill., must be extremely satisfactory to the stockholders of the company, as the statement shows profits of $413,941.54, and a surplus of $376,898.17, after paying a dividend of $122,275.66.

STEAM TURBINES FOR JAPAN.—The General Electric Company, Schenectady, N. Y., has received an order from Japan for thirty-seven Curtis steam turbines with electric generators. The total capacity of these turbines is more than 35,000 horsepower. Eleven of the turbines have already been installed and are operating satisfactorily.

THE INDEPENDENT PNEUMATIC TOOL COMPANY, Chicago, Ill., states that since it has acquired the Aurora Automatic Machinery Company, it has received a large number of orders for "Thor" piston air drills, and other pneumatic tools, and that its business has increased so materially that it has been forced to remove its offices to larger quarters, being now in rooms 1255-1257 of the First National Bank Building.

THE NEW JERSEY ASBESTOS COMPANY, Camden, N. J., reports increased activity in all departments, and is particularly gratified at the reception accorded its new high-pressure ring packing. In the South its business has increased to such an extent as to render it necessary to open a branch office. The company has secured the services of Mr. James O'Rourke, who was for a long time connected with the Southern Railway Company, and who is well and favorably known to both railway and supply men, as well as the trade in general, and who will have his office at 1718 First avenue, Birmingham, Ala.

THE YACHT ATLANTIC, winner of the transatlantic race, was equipped with a specially designed steering gear, made by the Edson Manufacturing Company, 255 Atlantic avenue, Boston, Mass.

THE ARMSTRONG CORK COMPANY IN ENGLAND.—Mr. Charles Bishop, formerly chief draftsman and engineer of the Linde British Refrigeration Company, of England, and also manager of the Haslam Foundry and Engineering Company, Derby, England, has taken the management of the British business of the Armstrong Company, Pittsburg, O. This company manufactures, besides life preservers, compressed cork upon a patented system, which is largely used for insulation both on land and sea, and for backing up armor plates, life belts, etc.

ALLEN PNEUMATIC RIVETERS IN DEMAND.—John F. Allen, 370 Gerard avenue, New York city, manufacturer of Allen riveting machines, reports a steady demand for these tools. July sales were as follows: Jeffrey Manufacturing Company, Columbus, O.; Thompson Iron Works, Philadelphia, Pa.; Owego Bridge Company, Owego, N. Y.; Manning Maxwell & Moore, New York; Levering & Garringues Company, Dunnelon, N. J.; Morava Construction Company, Chicago, Ill.; New Castle Bridge Company, Indianapolis, Ind; Interstate Engineering Company, Bedford, O.; American Car and Foundry Company, Wilmington, Del.; Cheboygan Boiler Works Company, Cheboygan, Mich.; American Car and Foundry Company, Jeffersonville, Ind.

STAYMAN VALVES ON THE ROOSEVELT.—The Stayman valve, manufactured by the Stayman Manufacturing Company, 143 Liberty street, New York city, has been installed on the Peary expedition's ship *Roosevelt*. The engine was a new one, with the customary plug piston which leaked. The company states that, at the request of Commander Peary, the original valve was removed and replaced by a Stayman valve. The action of this valve was such that the engineer was astonished to see the engine start immediately upon the mere touch of the throttle, whereas with the old valve it was necessary to open the throttle half way before the engine would move. The company states that this demonstrates that its valve is absolutely steam tight when in good working condition.

A RELIABLE BOILER COMPOUND.—The Bird-Archer Company, 209 Washington street, New York city, has received the following letter from J. R. Campbell, chief engineer of steam yacht *Wanderer*: "I beg to make a statement in regard to the results I obtained from the use of your marine boiler compound in the boilers of the steam yacht *Wanderer*. Being told by the inspector that any compound which would remove scale would injure my boilers, I made the following experiment before using the compound in my main boiler. After using sea water for thirty days in our donkey boiler, we opened the boiler and found scale three-eighths of an inch thick. We then refilled the boilers with sea water and added two gallons of your compound. After keeping steam on the boiler for forty-eight hours, we blew the boiler out and found the iron clean, the scale having been dissolved, and blown or washed out. After careful examination, no injurious effects to iron, seams or joints were noted, and in using the steam generated from the water after the compound was added, there were no injurious effects to valve faces or any of the rubbing surfaces, of any sort, where friction takes place. My main boiler will bear out all of the above statements, and would say that the compound was more than satisfactory, and it will always be used by me."

A NEW SAIL HOOK.—Capt. John M. Into, of yacht-racing fame, has invented and perfected a sail hook, which is made to replace the "old style" hitching hooks. The Into hooks are claimed to be proportioned with mathematical accuracy in order to safely meet the severe strains brought to bear upon them during a race. They are quickly operated, a feature which is most necessary, as a loss of ten seconds at a critical moment, during the changing of a sail, might give a competitor the lead and the race. These hooks have been used with success on the *Columbia*, *Reliance*, *Ingomar* and *Atlantic*, and have been adopted by the Herreshoff Manufacturing Company, Ratsey and Lapthorn, and others. A letter from Capt. Chas. Barr, of international racing fame, is herewith appended: "In reply to your letter, I beg to say that the reason we adopted your patent spring hook was because the ordinary snap hook, which we first used on the *Columbia*, was always getting afoul of something at a critical time and causing us lots of trouble. On many occasions the balloon jibtopsail caught the spinnaker and, besides tearing the sail, badly delayed us in getting the sails in, and on one occasion was the cause of our competitor getting past us. I have since used the Into hooks on the *Reliance* and the *Ingomar* and have never known it to foul anything, and the crew find it easy to work." The Delaware Marine Supply Manufacturing Company, Wilmington, Del., is sole manufacturer of the hooks.

CHAIN PIPE WRENCHES.—J. H. Williams & Company, manufacturers of drop forgings, Brooklyn, N. Y., state that they have two kinds of chain to sell with the "Vulcan" chain pipe wrench, but that one of them is superior to the other. The company's flat link chains are from 25 per cent. to 50 per cent. stronger than its cable chains, which the United States and the British governments have pronounced "unsurpassed."

DEPENDABLE HYDRAULIC JACKS.—Unless a hydraulic jack is absolutely reliable, the engineer, mechanic, railroad man or whoever is using it, is better without it. Just at the critical moment, when everything depends on a jack "standing up," a poorly made device is liable to give way. The consequences are best left to the imagination, they are not pleasant, even to imagine. In the Watson-Stillman hydraulic jacks, made by the Watson-Stillman Company, 46 Dey street, New York city, every such element of uncertainty is eliminated, say the manufacturers, hence the confidence reposed in them by those who have to trust life and limb to the dependability of a hydraulic jack. The cylinders and rams, for which, in some makes, so-called seamless tubing is thought good enough, are in the Watson-Stillman jacks forged from solid steel billets, forged and bored like the cylinder of a high class steam engine. Valves, glands, pistons, etc., are made and finished with equal care, packings and other parts subject to wear are easily accessible and replaceable, the result being a hydraulic jack thoroughly dependable and constantly ready for service. The manufacturers have a list of about 300 styles of hydraulic jacks, which they will send on request.

"IT HAS BEEN RUMORED SEVERAL TIMES," says an English exchange, "that the Admiralty has decided to deal with the question of watertight doors in a drastic manner. The present system is in many respects unsatisfactory, and there is no evidence that the Admiralty has profited by the terrible lesson conveyed by the *Victoria* disaster. Curiously enough, the navy which has most energetically faced the problem is that of the United States. In sixteen of their newest warships and cruisers what is known as the 'long arm' system, manufactured by the Long Arm System Company, Cleveland, O., has been adopted. By this means the bulkhead doors and armor hatches are electrically operated in such a way that the officer at the central station on the bridge by turning a wheel can close any one of the doors and hatches. While control is exercised from this central station there is no interference with local control. The officer on the bridge has the assurance that in closing any doors in case of emergency he is not endangering the life of anyone who may be in one of the compartments, because any such man, on whichever side of the door he may be, has within easy reach a handle by which he can himself control the movement of the door for sufficient time to enable him to escape. The system is worked by electricity instead of by hydraulic power, which is a considerable advantage, since the few wires which are necessary may be laid throughout the ship without difficulty. The 'long arm' system has been in operation in the American navy for a considerable time. The doors are tested every month, and the crew thus have every opportunity of becoming familiar with the system. In the *Victoria* disaster we had an illustration of the terrible results of an inadequate system of bulkheads. If the cellular structure of the ship is to be preserved and means of communication provided from compartment to compartment, it is essential that the officer on the bridge should be able to control the whole installation. The 'long arm' system of control possesses the advantages of electrical control from a central station without endangering any of the crew by the sudden closing of a door. The American navy is the only one which has adopted this method of dealing with the bulkhead door difficulty. It is said that the British Admiralty proposes to remove the source of danger by abolishing all communication by means of doors, each compartment being absolutely sealed and connection from one to another obtained only by means of passage above the water-line. It is evident that this method, if adopted, will lead to great waste of time and energy, and it will be interesting to know whether the authorities have seriously taken into consideration the solution of the problem which has recommended itself to the Navy Department at Washington."

A GOOD PACKING.—In packing a stuffing box, as much or more depends on the quality of the packing used as on the skill and care displayed by the engineer. A good packing must lay up easily, so that too much compression is not needed to make it tight. There must be a certain reserve of elasticity, as it wears or settles into its place. Crandall packing, made by the Crandall Packing Company, Palmyra, N. Y., is said to be an especially good packing. It is claimed to have the necessary resiliency. The wearing surface is a covering of braided long-fibre flax, impregnated by a cold oil process with a lubricant which not only increases its wear-resisting capacity, but obviates the friction inseparable from a tightly set up packing. Engineers who have used Crandall packing, are said to commend it highly for its resiliency, anti-friction effect and great durability.

ASSISTANT CYLINDERS FOR VALVE GEARS.—Mr. Luther D. Lovekin, 6320 Drexel Road, Overbrook, Philadelphia, Pa., has placed on the market an assistant cylinder for valve gears, which he states is a money saver for the steamship owner, a labor saver for the engine-room force, and a guarantee that the valve gear will work perfectly. Mr. Lovekin states that his invention may be applied to an engine, old or new, without difficulty, and that it is now in use on engines aggregating more than 130,000 horsepower, among which are the *Texan*, of the American-Hawaiian Steamship Company; the *Massachusetts* and the *Mississippi*, of the Atlantic Transport Steamship Company; the *Manchuria* and *Mongolia*, of the Pacific Mail Steamship Company, and the *Ontario*, of the Merchants' and Miners' Transportation Company. It has also been ordered fitted to the United States cruiser *Washington* and the United States battleship *Kansas*.

The longer an engineer uses Albany grease the more convinced he becomes that it is truly a panacea for all lubrication troubles, say Adam Cook's Sons, 313 West street, New York city, the only makers. They have received a letter from L. L. Moses, chief engineer of the United States hydraulic dredge *Jacksonville*, which is of decided interest in this connection, and reads: "I am a regular user of your product, and have always had the best of success with it. I am chief engineer of the United States hydraulic dredge *Jacksonville*, working on St. Johns River, Florida, and both of my assistant engineers, as well as myself, swear by Albany grease. We use it on main engine and all auxiliaries, and as we have thirty-three steam cylinders, we have ample opportunity to watch its work under different conditions."

Naval architecture by correspondence.—The Grand Rapids School of Mechanical Drawing, 361-363 Houseman Building, Grand Rapids, Mich., is teaching naval architecture by correspondence, and states that it has students enrolled all over the world who are successfully taking its course. Full details will be sent upon application, to those mentioning Marine Engineering. The following is a synopsis of the courses taught: Geometrical drawing—Terms in geometry illustrated and defined. Plates on pen exercises. A complete system of lettering for drawings, covering three complete plates. Essential problems in geometrical drawing, and such as are met with in every drafting room. Projections of drawings to show different views. Intersections and developments of surfaces. Issometric projections and how to rule your paper for drawing any object so that one view will give a practical idea of the complete construction. Synopsis of mechanical drawing—2. Conventional methods of representing screws. Methods of representing cross sections of different materials. Detail of band wheel. Detail of crank shaft and boxing. Details connecting rod and piston rod and braces. Detail of cross head. Detail of cylinder heads. Detail of steam cap and bolts. Details of slide valve. Detail of engine bed. Details of screws, bolts and nuts. Details of the eccentric. The complete elevation of a 7 x 12 steam engine from the details you have drawn. Plan view and rear elevation. This gives the complete designs and details in full for the 7 x 12 steam engine. 3. The student takes up the complete drawing of a two-horsepower gasoline engine and makes a full size drawing and puts on all of his own dimensions. He is required to make several views of engine and then take the same apart and detail each piece separately, make drawings, tracings and blue prints of same and send them in to the school for corrections. 4. The laying out of a drawing in detail which shows how to begin making the model for the twenty-foot launch. This is drawn to the scale of one inch to the foot and gives the necessary details to enable the student to go about his work in a systematic way. After the student has finished the drawing, he mails it to the school for corrections and approval and begins plate II, which deals further with the construction of the model, giving certain definite lines which are to be drawn according to sections and instructions. He now begins his wood work on the model and goes as far as instructions permit. He then begins on plate III, and at the same time works on his model until instructions have been completed. Details of the drawing of the model, and gives him necessary sections which show clearly how to finish forming the same. Model is taken apart and his lines or curves taken direct from the same onto paper and the sections and plan are given in full. The methods of drawing the proving lines, which gives great accuracy to the work, which is a great help to the builders. Drawings of the plan and cross sections and proving lines in condensed form. Sections of the complete boat. Plan side elevation showing the water-line. The plan view. Special plates on calculation of draught, displacement, and many other problems met with in naval or marine architecture by the latest methods. 5. Lines and sections necessary for the construction of the model of the thirty-eight-foot launch with cabin, which is entirely different shape. Side elevation of the complete launch. Sections through boat and cabin, there being sections so as to show very fully the construction of the cabin. Lines and sections for making the model for the sailing yacht, including the sailing plan. The student makes a complete drawing of the model that he has made according to his own ideas, as a sort of thesis work, and this is sent to the school for filing. This gives a sample of the student's work and is practically a thorough test of the work he has done The complete course in mechanical drawing consists of parts 1, 2, 3. The complete course in boat designing consists of parts 1, 2, 4. The complete course in naval architecture consists of parts 1, 3, 4, 5. For 50 cents in United States stamps the Grand Rapids School of Mechanical Drawing will send one full sized plate of geometrical drawing, one complete drawing of the gas engine in section, and one complete view of the 38-foot yacht, the 50 cents to be applied on course if you enroll as a student.

HELP AND SITUATION ADVERTISEMENTS.

Advertisements will be inserted under this heading at the rate of 4 cents per word. No advertisement will be inserted for less than 75 cents for the first insertion, and for each subsequent consecutive insertion the charge will be 1 cent per word. Cash must accompany the order. Replies can be sent to our care if desired, and they will be forwarded without additional charge.

POSITION WANTED.

Designing Marine Engineer, 41 years of age, married, desires to change position as Chief Engineer or Chief Draftsman. Fifteen years with present employers. Active, energetic, capable of handling a large number of men. Excellent references and good reasons given for wishing to change. Address ENGINEER, care Marine Engineering, 17 Battery Place, New York.

NAVAL ARCHITECT WANTS POSITION AND INVESTMENT.

Advertiser, 29, energetic, capable, 12 years' experience, ship and yacht building, now in good position with large shipbuilding firm, desires change to small yacht building firm or naval architect's office; invest $1,000 if desired; partially outside position preferred, with plenty work; references. Address, M. M. K., care Marine Engineering, 17 Battery Place, N. Y.

Power doors on new battleships.—Contracts have been let to the Long Arm System Company, Cleveland, O., for installing its electrically operated bulkhead doors and hatch gears on the United States battleships *Montana* and *South Carolina*. These two vessels are now in course of construction by the Newport News Shipbuilding and Dry Dock Company, Newport News, Va. The Navy Department specifications for these warships provided that "each (power) door must be capable of permitting operation on the spot by power or by hand from either side, and all such doors are to be capable of being closed by power simultaneously from an emergency station." The "long arm" system is the only one that could meet these requirements.

The Parsons Marine Steam Turbine Company, Ltd., 97 Cedar street, New York city, is prepared to grant licenses in the United States for the building of Parsons turbines for the purpose of marine propulsion. The advantages of the turbine system the company states to be absence of vibration, increased economy in coal consumption, reduced cost of attendance on machinery, reduced consumption of oil and stores, reduced diameter of propeller, giving increased facilities for navigating in shallow waters, and reduction in racing of propellers.

The following vessels have been classed and rated by the American Bureau of shipping, 66 Beaver street, New York city: American screw steamers *Onondaga, Guyandotte, Cerberus, Roosevelt, General Robert Swartout, General Timothy Pickering*, American schooner *Winifred A. Toran*, American three-masted schooners *Scotia, Marjorie A. Spencer, Georgia Gilkey, Annie C. Grace, Isaiah K. Stetson*, American half brig *Motley*, British schooner *Mersey*, British three-masted schooners *Nicanor, Drusie, Severn, G. M. Cochrane*, Russian three-masted schooners *Kuutsalo, Aurora*, and Swedish screw steamer *Transit*.

Both the engineer and the employer will gain by using "Double Service Packing," says the D. S. Paterson Company, Philadelphia, Pa. As the name indicates, says the company, the quality of the packing is such that you secure "double service." "This means a saving in time and trouble to the engineer, when obliged to repack only half as often as necessary with some other grades of packing. The employer not only economizes in the manner already shown, but also from the fact that, while made from material of the very highest quality, it establishes a standard of prices which are lower than many now prevailing. Engineers and employers are often dissatisfied with the packing which they have been using, but do not change because they are not sure what other kind to buy." To answer just such questions, this firm offers you the personal services of its packing expert, with more than nineteen years' practical experience, for which no charge is made, not even suggesting that you buy the company's packing. You are simply told the best kind to get for the work you have to do—the kind that will give best results. There is many a dollar wasted for packing which is not suited to the work for which it is used. To any engineer, mentioning Marine Engineering, this firm will mail, free of charge, a handsome "taken from life" colored picture, entitled, "Double Service."

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ADDRESSES OF CORRESPONDING SECRETARIES.

No. 1, W. D. Blaicher, 10 Exchange St., Buffalo, N. Y.
" 2, Wm. Kelly, 11 Wall St., Cleveland, O.
" 3, A. L. Jones, 289 Champlain St., Detroit, Mich.
" 4, James A. Macauley, 5802 Indiana Ave., Chicago, Ill.
" 5, Otto Boettger, 1035 E. Hopkins Ave., Baltimore, Md.
" 6, Wm. Arste, 322 Pine St., St. Louis, Mo.
" 7, Wm. T. McElwee, Box 1556, Portland, Me.
" 9, Wm. Bridges, 784 1-2 12th St., Milwaukee, Wis.
" 13, John G. Paulding, 1746 Tulip St., Philadelphia, Pa.
" 14, Joseph F. Dumas, 403 Dauphin St., Mobile, Ala.
" 15, R. L. Skinner, 622 Louisa St., New Orleans, La.
" 17, Jas. D. Robinson, 6th and Columbia Sts., Newport, Ky.
" 18, Wm. Hurst, 715 Walnut St., Cairo, Ill.
" 20, Jos. B. Barry, 206 Keel St., Memphis, Tenn.
" 21, J. H. Foley, 206 N. Mulberry St., Vicksburg, Miss.
" 23, Wm. R. Lewis, 213 E. Front St., Jeffersonville, Ind.
" 24, Hugh L. Edwards, 511 Washington St., Paducah, Ky.
" 26, T. H. Kirkbridge, 228 Bond St., Evansville, Ind.
" 27, L. C. Schwall, 598 S. Madison St., Bay City, Mich.
" 29, James R. Sutherland, Charleston, W. Va.
" 30, E. R. Humphrey, 21 State St., Pittsburg, Pa.
" 33, James J. Waters, 21-24 State St., New York, N. Y.
" 35, William M. Coombs, 36 East St., San Francisco, Cal.
" 36, Jos. Thomas, 57 Sea St., New Haven, Conn.
" 37, John B. Bender, 1215 Evesham Ave., Toledo, Ohio.
" 38, C. H. Wolford, 73 Starr Boyd Bldg., Seattle, Wash.
" 39, Frank Feeney, 460 E. 12th St., Erie, Pa.
" 40, Chas. Drouet, 1003 Ave. I, Galveston, Tex.
" 41, W. H. Marshall, 343 Holladay St., Portland, Ore.
" 42, Jas. Manning, 802 E. Duval St., Jacksonville, Fla.
" 43, A. J. Wilson, 1327 La Peer Ave., Port Huron, Mich.
" 44, Chas. J. Sullivan, 480 1st St., Manistee, Mich.
" 45, W. L. Salter, care O. S. S. Co., Savannah, Ga.
" 46, D. W. Farrell, Clayton, N. Y.
" 47, J. R. Cook, Sault Ste. Marie, Mich.
" 48, Alfred Hegemer, 140 E. Park St., Sandusky, O.
" 51, H. S. Connell, 12 Ranson St., Muskegon, Mich.
" 53, Harry Stone, Box 445, Marine City, Mich.
" 55, Archie Stalker, Box 883, Cheboygan, Mich.
" 57, E. B. Meeker, 71 Abeel St., Kingston, N. Y.
" 58, E. Capers Haselden, Box 31, Georgetown, S. C.
" 59, George F. Keating, 74 Webster St., E. Boston, Mass.
" 62, N. S. Lawrence, 30 Connecticut Ave., New London, Conn.
" 63, M. J. Burke, 152 Sheridan Ave., Albany, N. Y.
" 65, W. C. Palmer, care Consumers' Coal Co., Charleston, S. C.
" 67, James K. Dole, Saugatuck, Mich.
" 70, Charles T. Smith, 665 Commercial St., Astoria, Ore.
" 72, Wm. T. Findlay, 130 W. Bridge St., Oswego, N. Y.
" 73, E. M. Donahue, 1308 Cherry St., Green Bay, Wis.
" 75, Wm. D. Hemenway, Alexandria Bay, N. Y.
" 76, Orson Vanderhoef, Grand Haven, Mich.
" 77, John P. Hall, 1215 Huron St., Manitowac, Wis.
" 78, J. P. Burg, 2722 Minnesota Ave., Duluth, Minn.
" 80, Edward S. Welch, 338 Hamilton St., Albany, N. Y.
" 81, Jas. L. Sweeney, 206 E. Sarragosa St., Pensacola, Fla.
" 82, Fred H. Gowell, 427 Middle St., Bath, Me.
" 85, John A. Packard, 623 Merchant St., Alpena, Mich.
" 86, Sherman A. Smith, 737 Menekaunee Ave., Marinetta, Wis.
" 87, George B. Milne, 809 Fourth St., Detroit, Mich.
" 88, C. O. Chapman, S. B. Canal, Sturgeon Bay, Wis.
" 89, Geo. E. Willard, 4 Isabella St., Ogdensburg, N. Y.
" 91, A. L. McLaren, 130 W. Walnut St., Ashtabula, O.
" 92, Jos. D. Budd, Box 50, Sta. I, Saginaw, W. S., Mich.
" 93, W. J. Cook, 2220 G. St., N. W., Washington, D. C.
" 94, George R. Jones, Box 222, Washington, N. C.
" 95, P. J. McMahon, Box 199, Key West, Fla.
" 98, C. N. Vosburg, 6323 Patton St., New Orleans, La.
" 100, H. F. Mocine, Honolulu, H. I.
" 101, J. K. Cotton, Box 765, Norfolk, Va.
" 102, Fred. W. Linsemeyer, 210 Clinton St., South Haven, Mich.
" 103, A. E. Pittman, Box 378, New Bern, N. C.

TRADE PUBLICATIONS.

Reversible disk valves are described and illustrated in a booklet issued by the William Powell Company, Cincinnati, O. The booklet states: "For more than half a century the products of the Powell factories have been celebrated for superior excellence, and in one article especially—the 'Star' valves—have become, and still remain, the standard make of valves throughout the country up to the introduction of the 'White Star.' But while the 'Star' valve, so well known to the trade, was very satisfactory, yet we have ever striven to keep in the advance on the march of improvements; and as higher and higher steam-pressure service was demanded and adopted in steam engineering, we have constantly increased the efficiency of our product. This booklet is issued to introduce to the trade a radical improvement in valve construction. Our 'Star' valve, previously known so well as the best regrinding valve in the trade, is only surpassed by our 'White Star' product, and this booklet tells you the points of improvement referred to."

"How to Fight Fire" is the title of a booklet issued by the American-La France Fire Engine Companny, 149 Broadway, New York city. Referring to the company's "Babcock" fire extinguisher, which the United States Steamboat Inspectors have passed as filling all requirements for use on board ship, the booklet states: "Our 'Babcock' is the standard fire department extinguisher of the United States. There are over one million of them in use in the fire departments alone. It is especially adapted for any service where a regular force of men will be ready to handle it. It has been adopted by the United States government for use in arsenals. We have also installed thousands of them on railroads, steamboats, in packing houses, hospitals, hotels, theaters, etc. The 'Babcock' is a bottle-breaking machine, the acid being held in a sealed bottle. The bottle is crushed by a screw device in the head of the extinguisher whenever it is necessary to put the machine in operation. The whole contents of the bottle are at once mixed with the soda solution and immediate high pressure is the result. The stream from a 'Babcock' is controlled by a shut-off nozzle. The quantity of fire-quenching fluid in an extinguisher is of course limited and the value of being able to expend the stream with economy cannot be overestimated. The shell or cylinder of a 'Babcock' is made of one heavy sheet of copper without rivets or solder joints. The 'Babcock' is without question the most powerful hand fire extinguisher on the market to-day, especially adapted for use on steamboats, railroads, in warehouses, hotels, hospitals, etc."

"Searchlight Projectors" is the title of a booklet issued by the Carlisle & Finch Company, Cincinnati, O. The catalogue states: "We have embodied in our marine projectors all the latest improvements used in this class of apparatus. For lake and seagoing vessels projectors possess many advantages over the lights using silvered copper reflectors. The great accuracy of curvature of the mirrors produces a light of greater carrying power, which will render objects visible at over twice the distance possible with the silvered copper reflectors. The general arrangement of mirror and carbons will be readily seen by referring to the several illustrations following. Owing to the peculiar position of the carbons all the light produced at the arc is cast upon the mirror, and is then both reflected and refracted, so that it emerges from the lamp in a practically straight ray. A focusing screw and hand wheel are provided for varying the spread of the light. The mirror is contained in a spun copper bowl-shaped receptacle which protects it from moisture and damage. On 14-inch and 19-inch projectors the mirror may be swung out to one side for cleaning and trimming the lamp; but on the larger sizes the mirror is fixed, and trimming, etc., is done from the front end only. The weight of the projector is carried on a train of steel balls. The friction is thus so reduced that the lamp may be turned in either direction with the greatest ease. The most important requisite of a successful projector is that it be reliable. To this end we have carefully designed all the parts of our projectors. The base is made broad and heavy, and is of such width that the projector does not look topheavy, but on the contrary presents a most symmetrical appearance."

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS.

314 Madison Avenue, New York City.

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Catalogue No. 70, issued by the Peerless Rubber Manufacturing Company, 16 Warren street, New York city, manufacturer of "Rainbow" packing and other rubber goods, is a book of 136 pages, handsomely illustrated in several colors, and one that every engineer should send for. The catalogue gives the following as the history of "Rainbow" packing, and some of the claims the company makes for this packing: "'Rainbow' packing was first introduced in the year 1889 by Mr. Charles H. Dale. The entire process of the manufacture of this packing is a secret which is known only to Mr. Charles A. Hunter, our general superintendent, and Mr. Charles H. Dale, president of this company. Its origin was an accident. A prominent merchant made a suggestion to Mr. Dale, then general sales agent of this company, as to constructing certain material. In attempting to carry out his suggestion we met with failure, and found a large batch of compounded rubber on our hands. Our late superintendent, Mr. Deming, thought he could utilize this rubber and added different material to it, and colored it red, with a view of making sheet packing of it, and to our surprise was produced what all the world knows at the present time as the only effective flange packing in the world. Its color signifies nothing. It was simply a dirty brown color, and the coloring matter was originally put in to make it more presentable, and from the color its name, 'Rainbow,' originated. The fact exists that it stands alone to-day as the only packing in the world that can be put in a joint and full pressure of steam applied immediately without any baking or following up, with every joint guaranteed perfectly tight and true. 'Rainbow' is the acme of success."

Marine pumps and specialties are described in special Catalogue B. 106, issued by the George F. Blake Manufacturing Company, 114 Liberty street, New York city. This is a very complete and handsomely illustrated book of 156 pages, a copy of which will be sent free upon request to every reader of Marine Engineering mentioning this magazine. The introduction to the catalogue states: "Blake marine pumps have come to be so generally recognized as the standard in the United States, and types and designs have increased so rapidly in number during the past few years, that it has been considered necessary to issue this new marine catalogue. It would be impossible to illustrate and tabulate all the sizes and classes of pumps which we can furnish on short notice from patterns in stock. We would, therefore, be pleased to learn from our customers their special requirements, on receipt of which we will submit drawings, estimates, and full specifications. For marine service we have two standard constructions, as follows: (A) Water ends of hard, close-grained cast iron, lined with heavy composition liners; water pistons of composition, packed with fibrous packing of special quality; piston rods of Tobin bronze; valve seats and bolts of composition; valve springs of phosphor bronze. In most of the vertical-piston pumps the valve bolts extend down through the discharge-valve seat to the suction-valve seat, and a lock nut holds the seats and all movable parts in place. This type of construction is in general use on the majority of merchant vessels. (B) With the entire water end or air end of the pump of composition, otherwise fitted as above. This construction is customary in pumps for naval use, high-class yachts, etc. With each pump are furnished the required special wrenches, drip cocks, drain cocks, and lubricators; these fittings being included in the price. At an extra price the steam cylinders will be covered with the best quality of non-conducting material and lagged with Russia iron. We can also furnish, when desired, approved metallic packing for the steam piston rod and valve-stem stuffing boxes at a slight extra expense."

The September and October stock list, issued by the Scully Steel and Iron Company, Chicago, Ill., should be sent for by anyone interested in boiler, tank, and sheet steel, boiler tubes, wire rope, boiler braces, boilermakers' hand and power machinery, pneumatic tools, etc.

The Bantam Anti-Friction Company, Bantam, Litchfield Co., Conn., is sending out mailing cards calling attention to its anti-friction metal. It has been suggested that the town of Bantam change its name to Rogersville, in honor of Mr. W. H. Rogers, president of the company.

Smith & Robinson, engineers, 605 Provident Building, Philadelphia, Pa., are issuing a pamphlet in which they state that they are prepared to handle marine engineering, insurance, and general engineering promptly and economically, having had long experience in these special branches. The firm state that they make a specialty of the rearrangement of ships, machinery, and pipes, to give more efficient service, and that they survey and inspect all classes of vessels for insurance and repairs.

Dearing water-tube boilers are described and illustrated in a catalogue issued by the Dearing Water-Tube Boiler Company, Detroit, Mich. The company makes the following statements regarding its boilers: "The Dearing water-tube boiler was designed especially to meet the demand for high-pressure steam generators, and in its construction has been made to conform with the following requirements: (1) A perfect circulation in all its parts. There are in this boiler no conflicting currents; as all passageways are so designed that the circulation is continuous and uninterruptedly in one direction. The importance of perfect circulation in the water-tube boiler cannot be overestimated. We have seen water-tube boilers operated at a moderate rate of cost and giving fairly good results, but the moment they were crowded a little the circulation was found to be insufficient to prevent the tubes most exposed to the fire from overheating. When such overheating occurs, the life of the tube must be short, and the common result is the bursting of the tube, with the consequent delay and trouble in making repairs. (2) The use of such materials as practical use has shown to be the most suitable for the duty required. (3) Settling chambers, in which the action of the water in circulating deposits the impurities of the water in such a way that impurities may be readily removed by the use of a blow-off pipe. (4) The proportioning of heating surface so as to get the best results obtainable, and the placing of heating surfaces practically at right angles to the travel of the heat rising from the grates, by which arrangement the currents of heat are broken up and distributed through the generating tubes in such a way as to thoroughly absorb the heat into the water, and thus secure great fuel economy. (5) Steam dome properly proportioned, giving ample capacity for steam room, and sufficient water surface to allow the rising steam to easily separate from the water, thus giving the boiler a steady steaming capacity and a steady reliable water level, preventing priming, and in connection with a system of baffle plates, dry pipes, and superheating surfaces, insuring perfectly dry superheated steam. (6) A construction so much stronger than the actual requirements that the danger of rupture of any of the parts is practically done away with and at the same time so arranged that if a rupture should occur it would be confined to such a small part or section that it could not produce an explosion and could be readily replaced. (7) A construction which, in the event of repairs being needed, does not require the use of special tools, expert workmen, or material not easily obtained."

Mr. P. O. Herbert, Peters Building, Atlanta, Ga., will represent the Eureka Fire Hose Company, 13 Barclay street, New York city, in the south, in association with Mr. D. E. McGaw, Dallas, Tex., Mr. H. H. Alvis, Charlotte, N. C., and Mr. C. B. Payne, New Orleans, La.

Large orders for air ports.—The Delaware Marine Supply Manufacturing Company, Wilmington, Del., reports that it has on hand large orders for air ports for many shipyards on the Atlantic Coast and on the Great Lakes. One contract is for all the lights for the two ferryboats the Harlan & Hollingsworth Company, of Wilmington, Del., is building for the Central Railroad of New Jersey, and calls for an air port cast from the same pattern as those previously supplied by this company for similar vessels. The Delaware Marine Supply Manufacturing Company states that the 24-inch air ports it is now building are the heaviest air ports of this type ever constructed. The glass is 1¼ inches thick and the frame is made watertight by the use of four clamping screws.

Vertical variable-speed motors.—There is a large field in industrial-plant work for the vertical motor. Its use enables the machine designer to do away with the necessity of turned belt, beveled gears, etc. The equipment makes the driven machine more compact in arrangement and secures greater economy of operation than is possible by ordinary means of power of transmission. The Northern Electrical Manufacturing Company, Madison, Wis., states that it has paid special attention to the development of vertical motors, and in their design eliminates all of the trouble due to lubrication of a vertical armature shaft. The Northern vertical motor is said to be extensively employed in all fields of work. Where required the Northern single-voltage system is applied to the vertical motors, thus making it possible to operate the driven machine at the speed best suited to the requirements of the work. Simple controlling devices are used for the Northern single-voltage system and the motors operate from any ordinary two-wire, single-voltage, direct-current circuit.

The advantages of mechanical draft.—The B. F. Sturtevant Company, Boston, Mass., in its treatise entitled "Mechanical Draft," points out that to a great extent the advantages of this method of draft production are interdependent and that the possession of one advantage is evidence of the possession of others of similar character. "Thus the very adaptability of mechanical draft is indicative of the fact that it is more flexible than that produced by the chimney, is more readily controlled, and less influenced by climatic changes; while the apparatus for its production is more readily transported and has a higher potential value than a chimney. To a considerable extent these stand out as the convenience of this method, regardless of their economies. When it is shown that increased efficiency can be secured by a method that is more convenient the advantage of mechanical draft is established. The omission of the chimney is sometimes of far greater importance than would at first appear, while the readiness with which the rate of combustion may be increased is doubly appreciated when it is shown that under proper conditions the efficiency of combustion may be increased thereby. The purely economic features are presented most prominently in the ability to utilize low-grade fuels. The economy in the quantity of fuel consumed has, in its relation to the use of mechanical draft on shipboard, an advantage which is closely allied to that resulting from the decreased space occupied. The economic results which may be secured through the introduction of mechanical stokers and devices for utilizing the waste heat of the gases are rendered most evident under the conditions of mechanical draft production, as are also the great advantage of preventing smoke and the blessing of good ventilation as they are exemplified on shipboard. The facts that the size of a boiler plant required for a given output can be reduced when a fan is substituted for a chimney, that the cost of the mechanical-draft plant is usually far less than that of the chimney-draft plant, and that its operating expense is likewise less under proper conditions, all point to the purely economic advantages of the method which it is the purpose of this book to present. When these are considered in the light of the convenience and various other advantages of mechanical draft, its evident superiority to chimney draft must be conclusively established in the mind of anyone who has read these pages."

The Falls Hollow Staybolt Company, Cuyahoga Falls, O., has received orders for hollow staybolt iron bars from the Imperial Railway of North China, and from a leading railway of Japan.

The Dayton Pneumatic Tool Company, Dayton, Ohio, has appointed William Francis, 803 Empire Building, Pittsburg, Pa., its representative in the Pittsburg district. The company reports a satisfactory business, and additional equipment consisting of turret lathes, milling machines, etc., is being installed at its Dayton works.

CABLES USED FOR HOISTING PURPOSES, are subject to both internal and external wear. Unless they are kept well lubricated they wear and deteriorate rapidly. The Joseph Dixon Crucible Company, Jersey City, N. J., is putting on the market a graphite wire-rope dressing which is said to greatly prolong the life of wire ropes and cables.

THE BIRD-ARCHER COMPANY, 209 Washington street, New York city, manufacturer of marine boiler compounds, has received the following letter from Lewis J. Byrnes, chief engineer of the steam yacht *Kismet:* "After five months' use of your compound, under trying conditions, I have no hesitancy in saying it is the best boiler cleaner that has ever come under my notice. At the end of the season some of the tubes were removed for inspection. I was agreeably surprised at the clean, bright appearance of the tubes, my surprise being due to the fact that we use water from various sources along the coast, and carry high working pressure of 240 pounds. Dirty, and consequently leaky boilers, have long been a bane to the existence of the engineer. I think that in your compound we have found a long-sought relief."

Magnetic accelerators and couplings are described and illustrated in a pamphlet published by the Cutler-Hammer Clutch Company, Milwaukee, Wis., which makes the following statements in introducing its device: "Despite the remarkable progress of the past few years in mechanical and electrical lines, there remains one important detail in the art of power development and its distribution which, until recently, has shown little advance. The friction clutch of to-day, with its toggle joints, pivoted arms, sliding collar, etc., is a quarter of a century behind the modern apparatus in connection with which it is used. Compared to the self-contained automatic engine, with its clean and efficient oiling system, or the enclosed motor with its self-oiling bearings, the ordinary friction clutch with its grease cups, open and exposed working parts smeared with grease and dirt, is a relic of the past, and has been tolerated only because there was nothing to take its place. Designers, engineers, and mechanics, particularly those engaged in the design, application, or installation of power-distributing systems, are alive to the demand for a clutch which shall possess the advantages possessed by the machinery which makes up the remainder of the equipment with which the clutches are used. These advantages are: general neatness; an efficient automatic oiling system; ease and convenience of operation, automatic if desired; self-contained or enclosed working parts; durability, and reliability of operation. It is to meet these demands that we have designed and perfected the devices herein described."

BUSINESS NOTES.

THREADING AND CUTTING MACHINES, electrically driven, are advertised by D. Saunders' Sons, Yonkers, N. Y. This firm builds an electric motor-driven threading and cutting machine that is claimed to have many advantages over a belt-driven machine. There is nothing to attach or detach; the die head can be pushed to one side and the pipe cut without taking the die head off the machine or pushing the pipe over the chasers and spoiling them. An automatic pump keeps oil constantly on the chasers and cutting-off tool. Catalogue free upon application.

THE DEAN BOILER-TUBE CLEANER.—The William B. Pierce Company, 321 Washington street, Buffalo, N. Y., makers of the Dean boiler-tube cleaner, have just completed their 6,000th machine. This, the company states, shows that its claims in regard to the efficiency of the Dean cleaner is borne out by the facts. This cleaner is adapted for both water tube and return tubular boilers and its work is said to be very thorough in removing scale from both sides of the tube. The cleaner is remarkably simple in operation, say the makers, and is worked by either steam or compressed air, and as the barrel of the cleaner fits snugly into a water-tube boiler tube, it must remove all scale before it can pass any point. The cleaner works on the vibratory principle, and the rapid knocking of the hammer head on the tube knocks the scale off. The force of the blow is very light and no damage has resulted to tubes from its use. So confident is the William B. Pierce Company that its cleaner is the "best ever" that it will loan a cleaner to anyone for trial, and urge a comparison of its merits with any device known for removing scale. Steamships desiring to accept this trial offer will please send the size of tubes and type of boilers when requesting a trial cleaner. As a part of the guarantee accompanying the Dean boiler-tube cleaner the makers guarantee that the cleaner will pay for itself in fuel saved no matter what agent is not used for the removal or prevention of scale.

A rapidly-growing business.—A year ago, when the E. M. Dart Manufacturing Company, Providence, R. I., held its annual meeting, President Dart made a most gratifying report to the stockholders showing an increase of over 50 percent in business over the preceding year. The stockholders seemed to think that this would be high-water mark for some years to come, but orders have come in so fast during the past year and the size of the orders has been so large, that the present year will show an even greater increase over the preceding year than was the case a year ago. In order to keep up with the demand for Dart pipe unions and other specialties of this company, an addition to the present factory is being built which has an inside measurement of 41 by 114 feet. With this great increase in facilities for turning out work the company will be able to fill all orders promptly.

Marine machinery.—A number of complete outfits of marine steam machinery are now nearing completion at the shops of the Marine Iron Works, Chicago, Ill., that will be widely separated when they reach their final destination. One is for Burma, British India, which is the ninth outfit built by the same company for that district. A fore-and-aft compound outfit is for Cuba, and a duplicate of it for Nicaragua, as also Mexico. Some heavy service tugboat machinery (fore-and-aft compound) is for a Boston company operating on Gulf of Mexico, and a similar outfit in smaller size recently shipped for the new coast survey boat at New Orleans for the United States Engineer Corps. Two river steamers are to be shipped in the "knock-down" to Bolivia. Also a single-screw deep-water boat for similar shipment to the same country. A four-cylinder inboard surface condensing outfit for the new 100-foot steel steamboat being built at Frontera, Mexico, by the Bushnell Line (the Tabasco-Chiapas Trading & Transportation Company), that is nearly a duplicate, but larger than either one of the last shipments made to them by the same company. For the Yaqui River, in western Mexico, a difficult stream to navigate, the Marine Iron Works has received an order for a complete outfit for a vessel to ply in the merchandising and similar service. These, with some fore-and-aft compound condensing machinery for Montreal, Canada, and single-screw outfits for the Amazon, together with a fair amount of work for nearby customers, make the Marine Iron Works' shops quite busy, even during what would appear to be the dull season, with a gratifying amount of work in sight for the winter months.

HELP AND SITUATION ADVERTISEMENTS.

Advertisements will be inserted under this heading at the rate of 4 cents per word. No advertisement will be inserted for less than 75 cents for the first insertion, and for each subsequent consecutive insertion the charge will be 1 cent per word. Cash must accompany the order. Replies can be sent to our care if desired, and they will be forwarded without additional charge.

NAVAL ARCHITECT WANTS POSITION AND INVESTMENT.

Advertiser, 29, energetic, capable, 12 years' experience, ship and yacht building, now in good position with large shipbuilding firm, desires change to small yacht building firm or naval architect's office; invest $1,000 if desired; partially outside position preferred, with plenty work; references. Address, M. M. K., care MARINE ENGINEERING, 17 Battery Place, N. Y.

SHIPBUILDING ENGINEER SEEKS POSITION.

A Hollander, graduated from the Delft Technical University, first-class references, speaks and writes English, French, and German, desires position in shipyard; large salary not required. Address A. M. SCHIPPERS, Veaardingen, Holland.

DRAFTSMAN WANTS POSITION.

Young man with experience and education, practical, capable to assume full charge of designing and construction, wants position as shipbuilding draftsman in small yard. Address Y. X., care MARINE ENGINEERING, 17 Battery Place, New York.

WHO WANTS AN EXPERIENCED NEW YORK REPRESENTATIVE?

A man 40 years old, married, college graduate, 17 years' experience in shipbuilding as designer, in charge of construction, and engineer representative, having extended business acquaintance, desires position as sales representative in New York city of established firm connected with shipbuilding. Address EXPERIENCED, care MARINE ENGINEERING, 17 Battery Place, New York.

WIRE ROPE FOR TOWING HAWSERS.—The Durable Wire Rope Company, 288 Congress street, Boston, Mass., states that its rope is unequaled for ships' rigging, mooring lines, and towing hawsers. The company's cable-laid hawsers are made of four or five durable wire ropes laid around a specially treated Manila center, and are stated to be smaller and more flexible than Manila hawsers of equal strength. Bulletin No. 7 will be forwarded upon application.

"FUEL-OIL FURNACES AND EQUIPMENT has been our business for fifteen years," says the Rockwell Engineering Company, 26 Cortlandt street, New York city. Regarding its rivet forge, the company says "control, efficiency, economy, and practical indestructibility are governing qualities of a good heater. . . . This user of air and oil, or kerosene, induces the high, soft heat necessary to a superior forge. Hardening, tempering, and light forging are also feasible."

A COURSE IN INDICATOR INSTRUCTION.—The Indicator Instruction Company, Scranton, Pa., has for sixteen years made a specialty of teaching the use of the steam-engine indicator by correspondence. The company's original plan was to loan an indicator to students, while the course of instruction lasted, but there were so many applications from those who desired to own the instrument that the company now gives away a simple form of indicator to each student. A thorough knowledge of the use of the steam-engine indicator is indispensable to any engineer who hopes to rise in his profession. The indicator tells the horsepower developed; whether or not the boiler pressure is realized in the engine cylinder, and if not how much pressure is lost, due to a steam pipe too long or having too many bends, or from late or insufficient valve opening; whether waste steam is permitted to escape without undue back pressure; whether the work done by the head and crank ends of the cylinder and the high- and low-pressure cylinder of a compound engine is evenly balanced; whether there is any leakage by valves or piston; whether the engine is overloaded or underloaded; whether a larger engine should be used; and many other points the knowledge of which is essential for procuring the utmost efficiency of a steam plant. The Indicator Instruction Company states that its course is so simple that a man of very moderate education can readily master it. Particulars upon application.

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" 85, John A. Packard, 623 Merchant St., Alpena, Mich.
" 86, Sherman A. Smith, 737 Menekaunee Ave., Marinetta, Wis.
" 87, George B. Milne, 809 Fourth St., Detroit, Mich.
" 88, C. O. Chapman, S. B. Canal, Sturgeon Bay, Wis.
" 89, Geo. E. Willard, 4 Isabella St., Ogdensburg, N. Y.
" 91, A. L. McLaren, 130 W. Walnut St., Ashtabula, O.
" 92, Jos. D. Budd, Box 50, Sta. I, Saginaw, W. S., Mich.
" 93, W. J. Cook, 2220 G. St., N. W., Washington, D. C.
" 94, George R. Jones, Box 222, Washington, N. C.
" 95, P. J. McMahon, Box 199, Key West, Fla.
" 98, C. N. Vosburg, 6323 Patton St., New Orleans, La.
" 100, H. F. Mocine, Honolulu, H. I.
" 101, J. K. Cotton, Box 765, Norfolk, Va.
" 102, Fred. W. Linsemeyer, 210 Clinton St., South Haven, Mich.
" 103, A. E. Pittman, Box 378, New Bern, N. C.

TRADE PUBLICATIONS.

Powell's reversible disk valves are illustrated and described in a sixteen-page pocket-size catalogue distributed by the William Powell Company, Cincinnati, Ohio. There is a considerable amount of general information on the subject of valves, and those specifically referred to are well illustrated with sectional views showing in detail the manner in which the valves are made. The catalogue is more than ordinarily interesting, and every reader who has to do with purchasing or using valves should send for a copy of it.

Engineering specialties.—James L. Robertson & Son, 204 Fulton street, New York city, have issued a 64-page illustrated catalogue, and every engineer should send for a copy, as it contains a great deal of information which will be a great aid when ordering supplies. Regarding its indicator the catalogue says: "The Robertson-Thompson indicator is a modern instrument, and was designed for the attainment of the greatest accuracy when used in connection with the high speeds in use in modern engineering practice. It is wide, with perfectly-adjusted bearings, the moving parts are light, and the construction simple." Regarding the company's "take-up" device, the catalogue says: "Knowing the great trouble experienced in using detent motions on indicators to keep the cord from slipping off the drum, getting tangled and breaking, we have devised a take-up device which is so arranged that it can be put on indicators and take the place of a regular cord pulley. It can be used on reducing motions or any other attachment between the crosshead and drum of the indicator. The object of the device is to immediately pick up all slack cord which is found when detent motion is used on an indicator. The device is very simple, cannot get out of order, and requires no attention." Among the other specialties described in this catalogue are steam-damper regulators, Hine eliminators, Reliance safety water columns, copper-coil feed-water heaters, hot-water generators, regulating and reducing valves, pump governors, pressure regulators, steam separators, and grease extractors, automatic injectors, oil filters, exhaust-pipe heads, grate bars, grease cups, "Eureka" packings, packing tools, recording gauges, gauge-testing outfits, double-acting power pumps, planimeters, thermometers, oil pumps, and water gauges.

No handsomer catalogue has ever come to our notice than the one just issued by the Brown Hoisting Machinery Company, Cleveland, O. It is a large volume, 9 by 12 inches in size, heavily bound in cloth, and comprising two hundred pages. It is printed on very heavy coated paper and is given over almost exclusively to full-page photographs of various installations by this company. This company makes a specialty of designing and manufacturing complete plants for the rapid and economical handling of material, and it has been specially successful in installing high-speed gantry and cantilever cranes in shipyards, as well as a full line of cranes and hoists, such as are used in various ways in shipbuilding and in handling cargoes. Many of the large pictures show plants which this company has installed along the Great Lakes for the rapid handling of ore and coal. Each of the parts that go to make these hoists is handsomely illustrated and described, so that the text gives a very complete description of this company's system. Nothing could more graphically illustrate the immense traffic of our Great Lakes than the pictures in this handsome catalogue showing the facilities for handling coal and ore. Illustrations are also given of the many ore and coal-handling plants in various parts of the world—Cuba, Sweden, Italy, Mexico, England, and elsewhere. There are also illustrations of the coaling equipment in the United States naval station at New London, and at the Dry Tortugas Islands of Florida; illustrations of the manner in which ore, etc., is removed from the capacious holds of the big steamers on the Great Lakes; illustrations and description of the electric cantilever cranes in the Cramp shipyard, with much data regarding them; also some of the plants in the Newport News shipyard, the yard of Harland & Wolff, Belfast, Ireland, and in shipyards in Trieste, Austria; Newcastle-on-Tyne, England; U. S. Navy Yard, Brooklyn; Barrow-in-Furness, England; several yards of the American Shipbuilding Company on the Great Lakes, etc.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS.

314 Madison Avenue, New York City.

President, JOHN J. AMORY.
First Vice-President, H. A. LOZIER, JR.
Second Vice-President, CHARLES A. STRELINGER.
Third Vice-President, HENRY R. SUTPHEN.
Treasurer, J. S. BUNTING.
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Executive Committee, JOHN J. AMORY, *Chairman*: 1908, J. B. SMALLEY, JAMES CRAIG, JR., C. L. SNYDER, EUGENE A. RIOTTE, A. MASSENAT. 1907, JOHN J. AMORY, H. A. LOZIER, JR., J. S. BUNTING, H. N. WHITTELSEY, CHARLES A. STRELINGER. 1906, S. J. MATTHEWS, A. SNYDER, H. H. BRAUTIGAM, ALBERT E. ELDRIDGE, HENRY R. SUTPHEN.

The Du Brie gasoline engines, two- and four-cycle, are illustrated in a catalogue issued by the Du Brie Motor Company, 34 Brush street, Detroit, Mich. There are a number of pictures in the catalogue which show the general style and type of this engine, and the text would indicate that the sizes vary from 2 to 100 horsepower. Copies of the catalogue can be had free by the asking through the Du Brie Company.

Cincinnati milling machines and cutter grinders are very handsomely illustrated and completely described in an exceptionally attractive catalogue of 110 pages which is now ready for distribution. A copy of this catalogue can be had free by any reader of Marine Engineering upon application to the company. The catalogue illustrates this company's complete line of machines and attachments. Four new sizes of plain millers have recently been added by the company. All of them are designed for the quick handling of light work and are particularly adapted for the use of manufacturers of small devices. Among the new attachments will be found one for high-number indexing, one for rack indexing, an attachment for milling large cams and an attachment for milling worm wheels. There is also quite a little information regarding the use of electricity for direct application to these machines. There is also valuable information regarding high speed for rapid cutting.

Draftsmen and those who are interested or connected with drafting, should send to the Keuffel & Esser Company, 127 Fulton street, New York, N. Y., for a four-page circular which is being distributed regarding Duplex drawing paper No. 50. This circular contains much information regarding this paper and inclosed with it are samples of "Colonna" tracing paper, something new which this company is now offering to the trade. It is extra fine, strong, and very transparent paper, which takes ink, pencil, and colors well, stands considerable erasing, and its bluish tint makes it excellent for blue printing. It serves in many cases as a good substitute for tracing cloth. The company is also sending out samples of Duplex detail drawing paper, which has been one of the standard products of this company, having been first put on the market in 1881, and which is generally recognized as a most excellent detail drawing paper. It is tough, hard paper with resistant surface, and stands unlimited erasing, and is claimed to be equally well adapted for pencil, ink, and colors.

Corrugated concrete piles are described and illustrated in a catalogue issued by the Corrugated Concrete Pile Company, New York city. The following claims are made for these piles: "Concrete piles are better than the best wooden pile. They improve with age, whether wet or dry, and are indestructible; corrugated concrete piles eliminate the disadvantages of the ordinary concrete pile; they have, moreover, several marked advantages not possessed by any other pile; they are made in plain sight above the surface of the ground, and the reinforcement and compacting of the concrete are perfect; they are always perfect, because they are made where the inspectors can follow every step in the process; they can be inspected after completion and before driving; they save time, because they can be cast while the excavating is being done. Once driven, they can be loaded immediately if desired; they present more surface for skin friction than any other pile of the same cubical contents; they are driven with a jet working through the hollow core—only the final settling is given with a piledriver; they are theoretically right—that they are also practically right has been demonstrated by tests just completed in Sioux City, Ia."

Users of gas engines, and those of our readers who are interested in them, should send for a copy of the catalogue known as Circular No. 7, issued by the Toquet Motor Company, No. 1 Madison avenue, New York city. It is a neatly printed catalogue of fourteen pages, and gives detailed information regarding this company's motors of different sizes, and also instructions for installing them in boats. Inclosed in the catalogue is a circular containing testimonials from users of these engines. Among these testimonials is the following, which is typical of the others: "I have run gas engines for five years, and have used a number of makes, but like Toquet best. My engines have been in continuous use since last July and run as smooth as ever. I have run them for 23 hours without a stop, and for several weeks this fall ran them 16 to 20 hours out of the 24, as I was fishing at Plymouth, 48 miles down the coast, making a round trip every day. They have never given me any trouble or caused me to lose any time, and I have had to get no new parts yet. The separate bilge pump is very handy as it keeps a boat dry and does not have to be watched like those on other engines that go through water jacket. The spark control is good, being quick and positive. The parts are strong and the bearings very heavy. I have no fault to find with them. I have used them in all sorts of weather, wet and hot and below zero. They work all right under any conditions. I have towed a 75-foot fishing schooner against a strong tide with my boat."

Every reader who sends to the Standard Engineering Company, Elwood City, Pa., will have sent to him a series of blotting papers, on each of which is illustrated some machine or tool manufactured by this company. These tools include pipe threading and cutting machines, bolt threaders, and other specialties.

Lubricating oils are described in an ingenious folder which is being distributed by G. E. Hall, 211 Centre street, New York. All the reader needs to do is to "press the button" and the folder opens. This folder gives a brief description of the lubricating oils which Mr. Hall sells.

A free copy of a catalogue describing the Marsh tank and vacuum pumps, will be sent to all inquirers who write to the American Steam Pump Company, Battle Creek, Mich., and mention Marine Engineering. A special feature claimed for these pumps is the self-governing steam valve. There is no outside valve gear. A number of illustrations are given of different types of the pumps referred to, and there are tables giving the necessary information regarding suction and delivery, etc.

"American" power pumps and air compressors are described in an illustrated booklet issued by the American Steam Pump Company, Battle Creek, Mich.

Direct constant-feed milling machines are described in an illustrated folder issued by the Garvin Machine Company, Spring and Varick streets, New York city. The folder states that the company's new designs of milling machines are characterized by a number of important and original features, combined with the general unity of design adapted to secure efficiency for heavy service by a great increase in driving power, transmission of feed by the most direct means, and the large size of important-acting parts.

Users of fire extinguishers will have sent to them free upon request a booklet giving much information regarding putting out fires, by the American dry powder fire extinguisher, by writing to the American Chemical Company, Lebanon, Pa. This extinguisher has been on the market for many years, and is generally used in manufacturing establishments as well as on board vessels of all kinds. It is inexpensive, yet it is claimed to be one of the most efficient extinguishers on the market. One strong point claimed for this extinguisher is that while it destroys all conditions of fires, it does so without damage to property from chemicals, etc.

Mechanical oil pumps for steam engines, pumps, etc., are described and illustrated in a pamphlet issued by the Lunkenheimer Company, Cincinnati, O. Regarding its double-feed, mechanical oil pump, the company says that it is adapted for large tandem or cross-compound engines, where a reliable pump is required for two independent feeds; as, for example, to tap the steam chest over the steam valves of a Corliss engine, and in this way get the oil at once where it is most needed. The action of this pump is positive, and with every stroke of the plungers the oil is forced directly into the steam chests of cylinders. The pamphlet contains a number of letters from users of the Lunkenheimer oil pumps, expressing great satisfaction with their action.

Metallic packings are described in a booklet issued by the United States Metallic Packing Company, 427 North Thirteenth street, Philadelphia, Pa. Among other claims the company makes for its packing the booklet gives the following: "The main success of our packing is due to its flexibility; that is, no matter how badly an engine is out of line or how much play there is between crossheads and guides or between piston and cylinder, our packing floats with the rod, offering very little resistance. In fact, we do not know what it is to have a hot rod with our packing from any fault of the packing itself. This flexibility is due to the combination of the ball joint with the sliding face of the vibrating cup. Other types of packing not having this flexibility cause severe wear on rods and packing, and excessive friction."

Electric traveling hoists and trolleys are described and illustrated in a catalogue issued by the Niles-Bement-Pond Company, 111 Broadway, New York city. This catalogue states: "The economy of handling heavy material by electric traveling cranes is now so universally accepted as to be beyond question, but for the moving from place to place of loads weighing between one-half and five tons, the use of electric traveling cranes is not as universal as it should be. As the ordinary type of crane is frequently too expensive to justify its installation for this service, we have designed a line of electric traveling trolleys and hoists which are illustrated. These trolleys and hoists run on a single I-beam, making it possible to install them in places where it would be impossible to arrange for crane runways; the expense, too, of putting up the I-beam is comparatively slight. For loads above five tons, it is usually preferable to use our standard electric traveling cranes, which are described in our large crane catalogue."

"Small Motors" is the title of Bulletin No. 60, issued by the Crocker-Wheeler Company, Ampere, N. J. The bulletin states that any condition requiring small power applied electrically can be successfully met by the line of Crocker-Wheeler direct-current motors.

Every engineer should send for a copy of a four-page folder just issued by the Stayman Manufacturing Company, 143 Liberty street, New York, N. Y. The circular is neatly printed in colors, and contains large, well-executed engravings which explain in detail the novel features of the Stayman self-expanding pistons.

Those of our readers who are interested in technical books should send for a copy of a catalogue of selected books published by the Norman W. Henley Publishing Company, 132 Nassau street, New York. This catalogue describes a variety of books regarding electricity, machinery, gas engines, mechanics, steam engines, locomotives, air brakes, sheet metal work, etc.

"The Commercial Consumption of Fuel" is the title of a twelve-page folder which is being distributed by Waller & Renaud, 159 Front street, New York, N. Y. Every man who purchases or uses fuel will find some good points brought out in this folder, and we understand that copies will be sent free to all inquirers on referring to MARINE ENGINEERING.

Users of radiators for steam heating, whether for use on board ship or in buildings on shore, should send for a copy of a catalogue issued by the American Radiator Company, 282 Michigan avenue, Chicago, Ill., entitled "Popular Patterns of American Radiators." The catalogue is of convenient size, attractively printed and comprises about fifty pages, illustrating a large variety of radiators for all uses and purposes, and giving much other valuable information regarding the subject of heating.

Dart pipe unions, as made by the E. M. Dart Manufacturing Company, Providence, R. I., are thoroughly illustrated and concisely described in a neat catalogue which this company is distributing. There is not only the necessary information regarding the different sizes and types of unions, but also tables that the use of these unions would call for. There are also reproductions of letters from leading engineering concerns which have made use of this company's product, and something like one hundred and fifty names of prominent concerns in various parts of the United States which are extensive users of Dart pipe unions.

Users of valves should send for a copy of pamphlet No. 4, which is being distributed by the Golden-Anderson Valve Specialty Company, 105 Rike street, Pittsburg, Pa. The catalogue contains nearly forty pages, 5 x 7 inches in size, and on most of the pages are full-sized pictures, illustrating the several specialties described. These specialties include the following: Anderson cushioned non-return valves, combination cushioned non-return valves, cushioned triple-acting non-return valves, patent pressure reducing valves, automatic and counterbalanced valves, automatic valve and water columns, float valves, altitude valves, Golden patent automatic tilting steam traps.

"Automatic Belt-Tightening Idler" is the title of flyer No. 276, which is being distributed by the Crocker-Wheeler Company, Ampere, N. J. This flyer describes a newly-designed automatic belt-tightening attachment for the standard Crocker-Wheeler form L motor. The device may be used wherever the limited center distances between pulleys require an increased belt contact on the pulley surfaces. This device is so designed and supplied to the customer that it may be attached at any time to any L motor. Its principal parts are the idler pulley, arm and block, spring stud and block, and the adjustable spring and hook for connecting them.

New improved single frame standard guide steam hammers with reinforced guides and stiffened columns, as manufactured by the David Bell Engineering Works, Buffalo, N. Y., are illustrated and described in bulletin No. 805, which has just been issued. Copies of the bulletin will be forwarded free, upon request. This company now makes a specialty of steam hammers, building them practically in all sizes. During the past few months quite a number of hammers have been sold to the United States Government, and one order of three has been shipped to the Isthmian Canal Commission for use at Panama.

"Locks and Hardware" is the title of catalogue No. 18, just issued by the Yale & Towne Manufacturing Company, 9-15 Murray street, New York city. It is a handsome volume of about two hundred pages, 6 by 9 inches in size, and is intended especially for those who handle a regular line of the hardware referred to. Special and irregular kinds of hardware are omitted. Included in the first thirty pages or so is much technical information extracted from "A Treatise on Locks and Builders' Hardware," a handsome book written by President Towne of the company, and recently published by John Wiley & Sons, of New York. The different subjects covered by the several chapters in the catalogue are shown by the following headings: Padlocks, Night Latches, Dead Locks, Builders' Hardware, Locks in Sets, Keys and Blanks, Cabinet and Trunk Locks, Blount Door Checks, Chain Blocks, Special Products. At the end of the volume is a very complete index. There is also an interesting article on the Mechanism and Care of Locks, Lock Picking, Master-Keyed Locks, etc. We infer that any reader who is interested in this subject, and who uses locks and other hardware, will have a copy sent to him upon application.

BUSINESS NOTES.

The Falls Hollow Staybolt Company, Cuyahoga Falls, O., states that its hollow bars, made of soft steel, can be used to great advantage in many cases for hollow shafting.

I X L steam packing.—There has been placed on the market what is known as the I X L steam packing, which is claimed to have unusual powers of resisting the action of superheated steam, acids, ammonia, etc. The packing is easily applied, and is claimed to give absolutely tight joints for the highest pressures. The makers recommend it particularly for use in the packing of cylinder heads and steam chests, as well as piping, as it will not be pressed out or blown out from between the flanges. If properly applied at first it should not be necessary to tighten the bolts of the flanges afterward. It is believed to be the first non-metallic packing capable of withstanding a pressure as high as 15 atmospheres or a temperature as high as 900 degrees F. Moreover, it can be used with rough or unmachined flanges. It is made in all thicknesses, and is light in weight for a given surface. The $\frac{1}{16}$-inch thickness weighs only 5 pounds to the square yard. The packing is made by the I X L Steam Packing Manufacturing Company, and the selling agents are Frederick Vietor & Achelis, New York city.

The Indicator Instruction Company, 50 Columbia street, Newark, N. J., announces another improvement in the Simplex Indicator which accompanies its course of instruction, and it claims that these improvements have placed its indicators not only on an equality with the highest-priced makes, but in many respects above them, and that they are models of convenience and accuracy. This Simplex indicator is supplied to every student of the course as a loan during the progress of his studies, and for the present it has decided to make each student a present of the outfit as soon as his scholarship is paid up, without extra expense. The company has recently secured the service of Mr. F. Dobe, 95 Washington street, Chicago, Ill., to represent it in that city and vicinity, and it is also represented in Boston by Mr. D. S. Boyden, 43 High street. The company expects to secure representatives in other important cities in the near future, and is open for applications. Further particulars of the course of instruction, the indicator, and terms to representatives, may be had by addressing Mr. A. C. Lippincott, general manager, 50 Columbia street, Newark, N. J.

The United States Army transport service has been using the boiler compounds manufactured by the Bird-Archer Company, 209 Washington street, New York city, and Charles P. Wormwood, superintending engineer, has written the Bird-Archer Company the following letter: "Regarding the use of your Manhattan boiler compound and its value as a scale, grease, and oil remover from boilers as well as a preventative of scale forming in boilers, I respectfully advise you that after making a careful test on the United States Army transports of the Atlantic coast fleet, out of several compounds we have adopted yours for our use entirely, as it fulfills excellently the above qualifications. I have noticed on inspecting the boilers of the transports and tugs in my charge, that it has entirely removed the grease and oil without injuring the plates, and has also stopped pitting in many cases. This is something I have never known a compound to do before, which is naturally a great advantage to all marine engineers and owners of marine craft. I respectfully recommend your Manhattan boiler compound to those who are anxious to secure an article of merit."

SAVES FIFTY DOLLARS A DAY.—The Spence Manufacturing Company, 475 Broadway, St. Paul, Minn., recently installed one of its freight conveyors at the wharf of the Old Dominion Steamship Company, so that now freight is handled almost all the time by this electrically-driven device. Boxes, barrels, bales, and all sorts of freight are readily handled on this conveyor, and it is claimed to do more than twice the work that can be accomplished any other way. Indeed, the manufacturers claim that a conveyor will pay for itself in a few months, and on an ordinary line where there is much work to do will bring about a saving of fifty dollars or more a day in the expense of handling freight. A circular which is being distributed by the Spence Company states that by a simple device a record is kept of all packages transported and that the conveyor can be used at almost any angle. The machinery can be stopped instantly by pressing a push button. Because of the special way in which the traveler is made, inexperienced men can be used as well as those who are experienced. A guarantee accompanies the conveyor that from three thousand to five thousand packages can be handled per hour. Further information regarding this device can be secured by addressing the company.

MARINE REPAIRS.—The steamer *Grand Republic* has recently been sold to the Iron Steamboat Company, and is going to have a thorough overhauling and new boilers this winter, involving an expenditure of $50,000 to $60,000. The contract for the work has been awarded to the James Reilly Repair and Supply Company, 229 West street, New York city. The Reilly Company has just completed a new mooring pier in front of its works, foot of Sussex street, Jersey City, N. J., which gives practically 1,000 feet of water front for tying up vessels for repairs. The company is reconstructing its machine shop, and when the changes are made it will be one of the best-equipped and most conveniently located repair plants in the harbor of New York. Since the pier has been completed it has had moored alongside it the city boat *Minnahanonck,* which is being overhauled, and the company has overhauled the steamships *Buckman* and *Watson,* preparatory to their trip to the Pacific coast, in addition to miscellaneous repair work. This company is also constructing a new six-story building on the site of its headquarters, at 229-230 West street, New York, in which it will consolidate its supply department, which has entirely outgrown its present quarters at 233 West and 78-80 Beach streets.

Enlarged facilities.—Owing to the great increase in all branches of its business, the Marine Manufacturing and Supply Company, whose main offices are at 158 South street, New York, is moving its entire manufacturing department to New Brunswick, N. J. This department will occupy a new plant which fills the larger part of a city block, and which includes iron and brass foundries, a machine shop, blacksmith, and pattern shops, etc. This plant will be devoted to manufacturing steering wheels, windlasses, hoisting winches, crabs, derrick fittings, and a complete line of shipbuilders' and contractors' supplies.

Staybolt salesmen.—The Falls Hollow Staybolt Company, Cuyahoga Falls, O., has engaged Mr. F. C. Lippert, 595a Bartner avenue, St. Louis, Mo., as traveling representative for the western territory. Mr. Lippert is a graduate of Cornell University and a mechanical engineer of high standing. He has made the subject of staybolt iron a careful study and has gone into the matter very extensively. He is therefore fully equipped to explain the advantages of staying modern high-pressure boilers in an up-to-date and scientific manner. The Falls Hollow Company has just received an order for a quantity of hollow staybolt bars from the American Railroad Company, San Juan, Porto Rico. Also another large order for hollow bars for shipment to Japan.

Lackawanna motors.—Owing to the great increase in its volume of business, the Lackawanna Manufacturing Company has found it necessary to have much larger facilities, and has, therefore, moved into a large new plant at Newburg, N. Y., where all business will be attended to hereafter instead of at Buffalo. The valveless motors of this company distinguished themselves at recent contests at Niagara Falls. The Niagara Frontier Fish and Game Club held races in which twenty-two launches owned by members of the club were entered. The Niagara Falls (N. Y.) *Gazette*, of September 21, contains a full account of the races and states: "A noteworthy feature about the races was the fact that all three of the winning boats were propelled by the famous Lackawanna engines."

Rathbun-Lacy Company.—Messrs. Frank H. Lacy, V. E. Lacy, Jr., Edward Rathbun, and others, have organized the Rathbun-Lacy Company, at Toledo, O., to build a line of up-to-date gas engines of marine type. The company starts in with $30,000 capital stock, but expects in a very short time to largely increase this amount. A complete line of engines, both two-cycle and four-cycle, from the smallest to the largest horsepowers, will be built. All of the members of the company have had years of experience in connection with gas engines; Mr. Rathbun as designer and engineer for the S. M. Jones Company, V. E. Lacy, Jr., with the gas-engine department of the Pope Motor Car Company, and Mr. Frank H. Lacy is too well-known as a salesman of gas engines to need further introduction.

Lumber for shipyards.—Mr. Charles N. Crowell has recently gone into the lumber business at Orange, Tex., for the special purpose of supplying lumber of all kinds for use in shipyards. Mr. Crowell has also done considerable marine work himself, having recently built a dry dock in his own yard. This floating dry dock is a single box, length over all 332 feet, with a width of 95 feet, a depth of 14 feet, and a capacity of 5,000 tons. It was built on order from the New Orleans (La.) Dry Dock and Shipbuilding Company, and is constructed of fine quality of yellow pine timber largely in lengths of 60 feet. In addition to supplying lumber for builders of boats and vessels of all kinds, Mr. Crowell furnishes designs for dry docks and builds them under contract.

The improved heating apparatus for steam and electric railways, and for other purposes, manufactured by the Gold Car Heating and Lighting Company, 17 Battery Place, New York, N. Y., is very comprehensively and thoroughly illustrated and described in a finely-printed cloth-bound catalogue of 125 pages. This company's system is the result of twenty years or more experience, and the catalogue gives a great deal of information regarding the general subject of steam and electric heating, as well as of this company's specific system, which every man interested in engineering should know. All of the system which can be illustrated is shown by excellent cuts, and there are many sectional views of the different varieties and other attachments. Among these special features of particular interest outside of the heating is the Gold improved balance valve-pressure regulator, Gold's improved temperature regulator, Gold's improved automatic tee trap, Gold's improved vertical trap, Gold's improved system of hot-water circulation, Gold's ideal safety valve, Gold's improved storage system for heating compartment cars; also for heating refrigerator cars. This company's electric system of heaters is also fully illustrated and described. In the latter pages of the volume are a number of letters from railroad managers and superintendents and other large users of this company's specialties speaking of them in the most complimentary terms.

HELP AND SITUATION ADVERTISEMENTS.

Advertisements will be inserted under this heading at the rate of 4 cents per word. No advertisement will be inserted for less than 75 cents for the first insertion, and for each subsequent consecutive insertion the charge will be 1 cent per word. Cash must accompany the order. Replies can be sent to our care if desired, and they will be forwarded without additional charge.

The Ingersoll-Rand Company, of 11 Broadway, New York, announces the establishment of a branch office at Houghton, Mich., under the management of Mr. T. F. Lynch, who has for several years past represented the Ingersoll-Sargeant Drill Company in the copper and iron districts of the north. At the new office a complete stock of repair and duplicate parts for all Ingersoll-Rand pneumatic and other machinery will be carried, assuring the most ready service to patrons of the company in the territory covered.

New firm of naval architects.—Messrs. C. Sherman Hoyt and Montgomery H. Clark have formed the partnership of Hoyt & Clark, naval architects and engineers, with offices at 17 Battery Place, New York city. Mr. Hoyt has just returned from two years in Scotland, where he took the course in naval architecture at Glasgow University, and also was employed at the yard of John Brown & Company, at Clyde Bank, during the construction of the new Cunarders *Carmania* and *Coronia*. Previous to this he was connected with the Eastern Shipbuilding Company, at New London, Conn., and with the Townsend & Downey Company, at Shooter Island. Mr. Clark has been in the designing and surveying business in New York for the past three years, first under the firm name of Liljegren & Clark, and later under his own name. The firm will also do a yacht-brokerage business.

Motor drive for tools.—Manufacturers who plan the application of motor drive to machine tools are often unable to make satisfactory progress with the work because of the lack of information necessary to enable the electrical manufacturer to bid on suitable machines. The electrical manufacturer usually follows a request for quotations with a request for complete and detailed information regarding the motor equipment needed. The Northern Electrical Manufacturing Company, Madison, Wis., is able to send the purchaser quotations on Northern machines for application to machines and machine tool drive upon learning of the class of work to be accomplished and voltage of the power circuit from which the current is to be taken. The Northern Electrical Manufacturing Company has an extensive experience in all kinds of manufacturing plants applying motor drive for increased output and is usually able to determine upon the proper sort of motor equipment to be applied upon learning of the conditions.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

12 West 31st Street, New York.

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AMERICAN SOCIETY OF NAVAL ENGINEERS.

Navy Department, Washington, D. C.

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Advisory Board, WILLIAM F. YATES, 120 Liberty St., New York city; GEORGE F. KEATING, 74 Webster St., East Boston, Mass.; W. D. BLAICHER, 10 Exchange St., Buffalo, N. Y.

ADDRESSES OF CORRESPONDING SECRETARIES.

No. 1, W. D. Blaicher, 10 Exchange St., Buffalo, N. Y.
" 2, Wm. Kelly, 11 Wall St., Cleveland, O.
" 3, A. L. Jones, 289 Champlain St., Detroit, Mich.
" 4, James A. Macauley, 5802 Indiana Ave., Chicago, Ill.
" 5, Otto Boettger, 1035 E. Hopkins Ave., Baltimore, Md.
" 6, Wm. Arste, 322 Pine St., St. Louis, Mo.
" 7, Wm. T. McElwee, Box 1556, Portland, Me.
" 9, Wm. Bridges, 784 1-2 12th St., Milwaukee, Wis.
" 13, John G. Paulding, 1746 Tulip St., Philadelphia, Pa.
" 14, Joseph F. Dumas, 403 Dauphin St., Mobile, Ala.
" 15, R. L. Skinner, 622 Louisa St., New Orleans, La.
" 17, Jas. D. Robinson, 6th and Columbia Sts., Newport, Ky.
" 18, Wm. Hurst, 715 Walnut St., Cairo, Ill.
" 20, Jos. B. Barry, 206 Keel St., Memphis, Tenn.
" 21, J. H. Foley, 206 N. Mulberry St., Vicksburg, Miss.
" 23, Wm. R. Lewis, 213 E. Front St., Jeffersonville, Ind.
" 24, Hugh L. Edwards, 511 Washington St., Paducah, Ky.
" 26, T. H. Kirkbridge, 228 Bond St., Evansville, Ind.
" 27, L. C. Schwall, 598 S. Madison St., Bay City, Mich.
" 29, James R. Sutherland, Charleston, W. Va.
" 30, E. R. Humphrey, 21 State St., Pittsburg, Pa.
" 33, James J. Waters, 21-24 State St., New York, N. Y.
" 35, William M. Coombs, 36 East St., San Francisco, Cal.
" 36, Jos. Thomas, 57 Sea St., New Haven, Conn.
" 37, John B. Bender, 1215 Evesham Ave., Toledo, Ohio.
" 38, C. H. Wolford, 73 Starr Boyd Bldg., Seattle, Wash.
" 39, Frank Feeney, 460 E. 12th St., Erie, Pa.
" 40, Chas. Drouet, 1003 Ave. I, Galveston, Tex.
" 41, W. H. Marshall, 343 Holladay St., Portland, Ore.
" 42, Jas. Manning, 802 E. Duval St., Jacksonville, Fla.
" 43, A. J. Wilson, 1327 La Peer Ave., Port Huron, Mich.
" 44, Chas. J. Sullivan, 480 1st St., Manistee, Mich.
" 45, W. L. Salter, care O. S. S. Co., Savannah, Ga.
" 46, D. W. Farrell, Clayton, N. Y.
" 47, J. R. Cook, Sault Ste. Marie, Mich.
" 48, Alfred Hegemer, 140 E. Park St., Sandusky, O.
" 51, H. S. Connell, 12 Ranson St., Muskegon, Mich.
" 53, Harry Stone, Box 445, Marine City, Mich.
" 55, Archie Stalker, Box 883, Cheboygan, Mich.
" 57, E. B. Meeker, 71 Abeel St., Kingston, N. Y.
" 58, E. Capers Haselden, Box 31, Georgetown, S. C.
" 59, George F. Keating, 74 Webster St., E. Boston, Mass.
" 62, N. S. Lawrence, 30 Connecticut Ave., New London, Conn.
" 63, M. J. Burke, 152 Sheridan Ave., Albany, N. Y.
" 65, W. C. Palmer, care Consumers' Coal Co., Charleston, S. C.
" 67, James K. Dole, Saugatuck, Mich.
" 70, Charles T. Smith, 665 Commercial St., Astoria, Ore.
" 72, Wm. T. Findlay, 130 W. Bridge St., Oswego, N. Y.
" 73, E. M. Donahue, 1308 Cherry St., Green Bay, Wis.
" 75, Wm. D. Hemenway, Alexandria Bay, N. Y.
" 76, Orson Vanderhoef, Grand Haven, Mich.
" 77, John P. Hall, 1215 Huron St., Manitowac, Wis.
" 78, J. P. Burg, 2722 Minnesota Ave., Duluth, Minn.
" 80, Edward S. Welch, 338 Hamilton St., Albany, N. Y.
" 81, Jas. L. Sweeney, 206 E. Sarragosa St., Pensacola, Fla.
" 82, Fred H. Gowell, 427 Middle St., Bath, Me.
" 85, John A. Packard, 623 Merchant St., Alpena, Mich.
" 86, Sherman A. Smith, 737 Menekaunee Ave., Marinetta, Wis.
" 87, George B. Milne, 809 Fourth St., Detroit, Mich.
" 88, C. O. Chapman, S. B. Canal, Sturgeon Bay, Wis.
" 89, Geo. E. Willard, 4 Isabella St., Ogdensburg, N. Y.
" 91, A. L. McLaren, 130 W. Walnut St., Ashtabula, O.
" 92, Jos. D. Budd, Box 50, Sta. I, Saginaw, W. S., Mich.
" 93, W. J. Cook, 2220 G. St., N. W., Washington, D. C.
" 94, George R. Jones, Box 222, Washington, N. C.
" 95, P. J. McMahon, Box 199, Key West, Fla.
" 98, C. N. Vosburg, 6323 Patton St., New Orleans, La.
" 100, H. F. Mocine, Honolulu, H. I.
" 101, J. K. Cotton, Box 765, Norfolk, Va.
" 102, Fred. W. Linsemeyer, 210 Clinton St., South Haven, Mich.
" 103, A. E. Pittman, Box 378, New Bern, N. C.

TRADE PUBLICATIONS.

A free sample can full of mineral machine oil will be forwarded to any reader of MARINE ENGINEERING by G. E. Hall, 211 Centre street, New York city. This oil is said to be suitable for either heavy or light work.

Drop forged machine wrenches are described and illustrated in a booklet issued by the Billings & Spencer Company, Hartford, Conn. There are more than fifty illustrations showing the many varieties of wrenches which this company manufactures for every conceivable purpose. One illustration shows a picture of 45 different drop forged wrenches assembled together.

Every user of packing and gaskets should send for a booklet entitled "A Few Remarks by Father Knickerbocker," which is being distributed free of cost by the Peerless Rubber Manufacturing Company, 16 Warren street, New York city. The booklet describes in a sort of story form the uses for rainbow packing, eclipse gaskets, etc., and is illustrated with about a dozen or more amusing little pictures.

A free copy of a very neat catalogue, known as "Ideal" catalogue No. 7, will be sent to all inquirers by Gustav Wiedeke & Company, Dayton, Ohio. The catalogue comprises over fifty pages in which there will be found complete descriptions as well as illustrations of the various tools which this firm manufactures. Among these tools are the following: Mandrels, sectional beading, tube expanders, as well as a variety of other tube expanders for general and special uses, self-feeding tube cutters, standard punches and dies, tube hole shearing punches, ratchet drills, together with jacks, reamers, taps, etc.

"Oil Fuel for Ships" is the title of a handsome catalogue just issued by Tate, Jones & Company, Incorporated, Frick Building, Pittsburg, Pa. Every reader of MARINE ENGINEERING who is at all interested in the subject of fuel oil should send for a copy. Following are some of the subjects treated: The advantages of oil fuel; proper methods and conditions for burning fuel oil under boilers; records of the apparatus as manufactured by this company for using oil, and showing the manner in which it is adapted to boilers for use on ships. There are a number of very complimentary letters from users of this company's system, together with a report of record runs which different steamships have made with fuel oil.

"Mechanical Draft, What It Is and What It Does," is the title of a booklet issued by B. F. Sturtevant Co., Hyde Park, Mass. This booklet not only briefly presents the salient features of this system of draft production, but illustrates a variety of plants which clearly show "what it is." The suggested query in the words "what it does" is answered thus: *It does* what an ordinary chimney is incapable of doing. Its cost is from 20 to 40 percent of that of a chimney; its intensity permits of the burning of finely divided or low-grade fuel; it makes possible the utilization of the heat of the flue gases which a chimney wastes in producing draft; it is independent of the weather; is automatically regulated to maintain constant steam pressure, decreases smoke, increases the capacity of an existing plant, and serves as an auxiliary to a chimney already overburdened; saves space and is portable.

Steam specialties, such as self-cleaning steam traps, gauge cocks, low pressure water feeders, etc., are described and illustrated in a circular issued by George W. Neff & Co., 42 Broadway, New York City, successors to Bailey, Brown & Bailey. Regarding the "Vesuvius" self-cleaning steam trap the circular states that it "differs so radically from other makes that a word of explanation is necessary. The incoming water is received in the copper gravity bucket situated in the dome of the trap. This bucket is so balanced that when nearly full it upsets. The water is thus delivered for the action of the valve in sudden quantities. The outlet is closed by the ball which is held in position by the pressure. When the bucket discharges, the float rises suddenly, pulling the ball from its seat by means of a lever and clutch. As soon as released the ball falls to the lever below, leaving the outlet wide open. This action of the bucket also serves to keep off dirt, sediment, scales, etc., in suspension, and while in that condition it is constantly being blown out of the trap. When discharging water the valve is wide open, never partially open."

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS.

314 Madison Avenue, New York City.

President, JOHN J. AMORY.
First Vice-President, H. A. LOZIER, JR.
Second Vice-President, CHARLES A. STRELINGER.
Third Vice-President, HENRY R. SUTPHEN.
Treasurer, J. S. BUNTING.
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Executive Committee, JOHN J. AMORY, *Chairman*: 1908, J. B. SMALLEY, JAMES CRAIG, JR., C. L. SNYDER, EUGENE A. RIOTTE, A. MASSENAT. 1907, JOHN J. AMORY, H. A. LOZIER, JR., J. S. BUNTING, H. N. WHITTELSEY, CHARLES A. STRELINGER. 1906, S. J. MATTHEWS, A. SNYDER, H. H. BRAUTIGAM, ALBERT E. ELDRIDGE, HENRY R. SUTPHEN.

Pipe-bending machines are illustrated and described in a circular issued by the Chicago Pneumatic Tool Company, Chicago, Ill. The circular states: "A great number of these bending machines are in use in shipyards, railroad shops, and pipe shops in both the United States and foreign countries, and have in every case proven themselves to be an indispensable adjunct to all well-equipped shops where such service is required."

Wood Craft is the title of a new trade journal published by the Gardner Publishing Company, Cleveland, Ohio. The magazine is of standard size and the first number contains 72 pages. The new magazine, it is announced, will deal with the general field of wood working, and will go to pattern makers, cabinet makers, furniture factories, launch and boat builders, etc.

Users of steam pumps will have a card sent to them by the Buffalo Steam Pump Company, Buffalo, N. Y., if they refer to Marine Engineering. This card contains pictures of eight different types of pumps which this concern manufactures; also an interesting picture of an old-fashioned hand fire engine, such as was used by the volunteer fire brigades forty or fifty years ago.

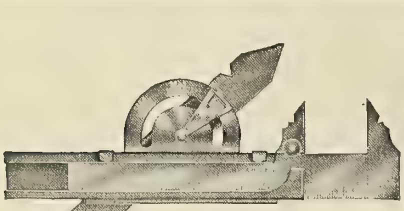
There will be a flutter in the hands of everyone of our readers who will send to A. C. Clark & Company, Randolph street, corner Michigan avenue, Chicago, Ill., for one of the flutter bugs which this firm is sending free to all enquirers in connection with a concise description of the Clark mechanical boiler cleaner. This device, as stated in the folder, "is not a flue cleaner but a boiler cleaner."

Baxter D. Whitney & Son, Winchendon, Mass., manufacturers of wood working machinery, are issuing a handsomely printed and illustrated booklet giving the history of the firm and describing some of its wood working machinery. The booklet states: "The Baxter D. Whitney works have been in operation under the same management since they were established sixty years ago. It has always been the intention to deal honestly. It is still the intention to deal honestly. This business principle is the Whitney guarantee."

Air-cooled Duntley electric drills have a special circular known as No. 52 devoted to them, which is published and distributed by the Chicago Pneumatic Tool Company, Fisher Building, Chicago, Ill. A number of illustrations are given of different types of drills, and the necessary information regarding full currents, etc., accompanies them. These drills are adapted to a wide range of work and can be used to advantage in all sorts of places, in many of which other drills could not be used. They are regarded as especially economical, particularly for portable tools.

Electric storage batteries for ship and yacht lighting, for signal lights, electric launches, gas-engine igniters, and other such purposes are fully described in a series of folders and bulletins issued by the National Battery Company, Buffalo, N. Y. In addition to the several general circulars, there are a number of special ones. Bulletin No. 1 refers to the use of this company's storage batteries in its telephone exchange. Bulletin No. 2 is a complete description of a storage-battery plant used in connection with a water-power system. Bulletin No. 3 describes a plant of these batteries for car-lighting purposes.

The November number of the *Progress Reporter,* published by the Niles-Bement-Pond Company, 111 Broadway, New York City, describes and illustrates several large machine tools, such as a 30-inch lathe, a 3 x 36 turret lathe, a 6-foot Niles standard universal radial drill, plate straightening rolls, etc. The *Progress Reporter* is issued at short intervals by the Niles-Bement-Pond Company with the object of informing the public generally and the employees of the company regarding the new machines and devices which are constantly being brought out. Any one interested will be placed upon the free mailing list.



A new, handy and convenient device for taking measurements is the Wirt-Goethe combination gauge. One is often confronted by almost insurmountable difficulties, when called upon to perform some mechanical work, because he has not handy the right kind of a tool to take measurements. The device here shown performs the work of ten different tools, and is so compact that it is easily carried in the vest pocket. It is made of superior steel, carefully and thoroughly tested as to its accuracy, and is enclosed in a neat leatherette case, with metal trimmings. Readers of Marine Engineering may secure this tool at a very low price for a limited time only. All that is necessary is to send your name and address and two dollars to Howard S. Moss, Jobbers' Representative, Room 717, Ogden Building, Chicago, U. S. A.

"A Powerful Illustration" is the title of a folder issued by the Mianus Motor Works, Mianus, Conn., with the object of calling attention to one of the company's 4-horsepower engines, towing 12 boats and 44 men. An illustration of this feat accompanies the folder.

Wire rope for cables, hawsers, power transmission and many other uses, is described in a 64-page illustrated catalogue issued by the Macomber-Whyte & Moon Rope Company, 122 Centre street, New York city. In the rear of the catalogue are several pages devoted to test tables, useful information, etc.

"This is the Grip You Would Use on a Pipe to Turn it by Hand," is the title of an illustration on a folder issued by the Bullard Automatic Wrench Company, Providence, R. I. The company states: "The same grip is applied mechanically with a Bullard automatic wrench. All of the pressure on the handle goes to turn the pipe. The Bullard will not crush the lightest pipe."

Northern forge blowers are illustrated and described in leaflet No. 145, issued by the Northern Electrical Manufacturing Company, Madison, Wis. These forge blowers are manufactured in sizes ranging from 127 to 277 pounds, and the revolutions per minute range from 2,200 to 1,600.

"Will One Hundred Percent on Investment Interest You?" is the title of a pamphlet issued by the American Blower Company, Detroit, Mich., describing its "A. B. C." Type A engines. The pamphlet states that two engines each cost $250, the saving in the cost of operation being $234 per annum. Full particulars are given in the pamphlet which will be mailed upon application to all interested.

The safety stop valve, McLaughlin type, will be found well illustrated and described in an eight-page folder known as Catalogue A, issued by McLaughlin Brothers, Land Title Building, Philadelphia, Pa. A reproduction of drawings from the patent papers shows in detail the design of the valve, and pictures are given of the exterior, so that a very comprehensive idea of the valve is given.

The Rockwell annealing and hardening furnace, designed for oil or gas fuel, is described in a circular issued by the Rockwell Engineering Company, 26 Cortlandt street, New York city. This furnace is designed for hardening, tempering, case hardening, and annealing, as applied to making of tools, dies, taps, punches, cutters, screws, springs, machine parts, etc., requiring great uniformity of temperature. This company's furnace is said to be simple and strong, and one that should last for many years without repairs.

Northern ring-type machines, for power and lighting service, are described in Bulletin No. 51, issued by the Northern Electrical Manufacturing Company, Madison, Wis. The bulletin states that in common with other manufacturers of electrical machinery, the Northern Electrical Manufacturing Company produces a line of dynamos and motors for large ratings. These are constructed in ring-type fields, which is the subject of the present bulletin, a free copy of which will be forwarded to all applicants mentioning MARINE ENGINEERING.

Automatic exhaust relief valves, suitable for reciprocating or turbine engines, made in horizontal, vertical, and angle pattern, are illustrated and described in a circular issued by Crane Company, Chicago, Ill. The circular states: "These valves are designed to provide a means of promptly relieving a condenser in the event of the vacuum being lost. They are a necessity in every condensing plant, as, should the vacuum be broken through any cause, the steam, not having a free exit, will destroy the condenser valves or possibly wreck the whole system."

"Questions and Answers for Engineers," by Theodore Lucas, is a book containing 807 practical questions covering all branches and departments of the marine engineer's profession. The price is two dollars, and the book is sold by Theodore Audel & Company, 63 Fifth avenue, New York city.

The Marck steam trap is described and illustrated in a catalogue issued by E. F. Houghton & Company, 240 W. Somerset street, Philadelphia, Pa. The catalogue states: "To show our faith in the Marck steam trap, every trap is sent out upon a 30 days' trial, and after that guaranteed for a period of two years."

Crosby recording instruments, particularly the Crosby pressure recorders, the Crosby pressure recorder and gauge, and the Crosby gas, mine, and draft recorders, are illustrated and described in a neatly-printed four-page folder, copies of which can be had upon application to the Crosby Steam Gauge and Valve Company, Boston, Mass.

Electric motors and dynamos are described in illustrated Bulletin No. 4, issued by the Barriett Electric Manufacturing Company, Cincinnati, O. It is claimed for these motors that they are of superior design, especially made for use in operating machinery where reliability is essential, and in places where the cost of operation is more important than the first cost of the motor.

Pneumatic tools are concisely and handsomely illustrated in a 64-page catalogue issued by the Cleveland Pneumatic Tool Company, Cleveland, Ohio. This company manufactures pneumatic tools for every conceivable purpose and any one interested in the subject should not fail to send for a free copy of the catalogue.

The American Blower Company, Detroit, Mich., is publishing neatly-printed specifications of its "A. B. C." vertical, high-speed, automatic engines. The company gives a written guarantee that the engines will develop indicated horsepower when operated under certain stated conditions. Copies of these specifications will be forwarded free to all who mention Marine Engineering.

Filing cabinets, sectional and solid; vertical filing systems and card-index record systems, are illustrated and described in a very complete 66-page catalogue issued by the Wagemaker Furniture Company, Limited, Grand Rapids, Mich. Managers of shipyards or of factories of any kind contemplating installing a filing-cabinet system should be sure to send for a Wagemaker catalogue.

Pop safety, water and hydraulic relief valves, cylinder relief and snifting valves, blow-off valves, chime whistles, pressure and vacuum gauges, revolution counters, marine clocks, pressure-recording gauges, thermometers, and other marine specialties are illustrated and described in Catalogue No. 12, issued by the Ashton Valve Company, 271 Franklin street, Boston, Mass.

Machinists' tools are described in a very complete illustrated catalogue of 156 pages, issued by the Brown & Sharpe Manufacturing Company, Providence, R. I. Rules, squares, micrometer calipers, gauges, accurate test tools, milling machines, grinding machines, gear-cutting machines, screw machines, and cutters, are the principal tools manufactured by this company, which will be pleased to forward a free copy of its catalogue upon application.

Nautical instruments are described in a 30-page illustrated catalogue issued by the Keuffel & Esser Company, 127 Fulton street, New York city. Sextants of many patterns, binnacles of half a dozen kinds, peloruses, liquid compasses, dry compasses, aneroid barometers, marine glasses, and, in fact, every instrument that a navigator uses, will be found listed in this catalogue, which also illustrates and describes drafting-room tapes and instruments of all sorts.

"**Type N. Motors,** Especially Designed for Crane Service," are described and illustrated in Bulletin No. 223, issued by the Sprague Electric Company, 527 West Thirty-fourth street, New York city. The catalogue states that modern shop requirements demand facilities for handling raw material as well as assembled parts with maximum speed and minimum cost, and that this demand is now met with electric cranes, which it is claimed are the most satisfactory cranes now in use.

BUSINESS NOTES.

A COAL-SAVING VALVE.—The Stayman Manufacturing Company, 143 Liberty street, New York city, has placed on the market a new self-expanding piston, which the company states saves coal, because the self-expanding feature avoids friction in the cylinder, while the valve is steam tight at all points, and is said to be the most perfectly controlled valve on the market. The company gives a five years' written guarantee.

THE MACOMBER-WHYTE-MOON COMPANY, 130 Centre street, New York city, is advertising galvanized flexible steel hawsers, mooring lines, standing rigging, and wire hoisting ropes. The company states that manila rope cannot hold its own with the Macomber-Whyte-Moon steel ropes, which, it says, are much stronger, lighter, and cost less than any manila or fiber rope made. Free catalogue will be sent to all applicants who mention MARINE ENGINEERING.

THE RECOMMENDATION OF UNCLE SAM is proof positive that one's goods or products are all that is claimed of them, say Adam Cook's Sons, 313 West street, New York city. Albany grease is used and endorsed by both the War and Navy Departments, and only recently Rear-Admiral John Lowe states in writing to Adam Cook's Sons, the only makers of this lubricant: "I have been the means of using tons of Albany grease, and consequently may be presumed to know its merits."

THE ELLIS & EAVES INDUCED DRAFT, manufactured by John Brown & Company, whose American representative is Mr. W. Carlisle Wallace, 22 Thames street, New York city, will, so it is claimed by the manufacturer, increase the efficiency of boilers 33⅓ to 50 percent, with a very slightly increased cost. The system may be installed on any marine or land boiler, and may be operated without difficulty bv the regular engineering force. It is used in the larger navies of the world as well as in the merchant marines of all countries. For full particulars address Mr. Wallace.

JAPANESE ORDERS FOR MACHINERY and tools to American manufacturers.—L. S. Starrett Company, Athol, Mass.; Pratt & Whitney Company, Hartford, Conn.; Brown & Sharpe Manufacturing Company, Providence, R. I., and the Nicholson File Company, Providence, R. I., have received large contracts from Japan for tools and machinery to be used by the government. Much of the heavy machinery ordered is to be used for forging armor plate, and for repairing the damaged Russian vessels captured by the Japanese.

PNEUMATIC TOOL APPLIANCES.—Fred Duell, proprietor of the Seneca Machine Works, Seneca Falls, N. Y., manufactures a line of chisels, calking-tool blanks, and beading tools, for use in connection with pneumatic hammers. He also manufactures punches and dies. In order to still further introduce these tools to the trade, he offers to send tools on trial to responsible parties. The tools manufactured by this concern are not new by any means, having been on the market five years and having already made a most excellent reputation for themselves.

TEN CENTS ON THE DOLLAR.—Messrs. Hill, Clarke & Company, 156 Oliver street, Boston, Mass., are offering two special bargains in small tools. One comprises a lot of odd sizes of card-machine screw taps which the firm has in stock. These taps, of which the usual list price is thirty-five cents, are offered at the special price of three and a half cents each. The other bargain is a similar lot of odd sizes of card hand taps, which are offered at twenty-five cents on the dollar. For instance, taps which are listed at one dollar and twenty cents are sold at thirty cents.

WILL ENLARGE ITS PLANT.—The Quintard Iron Works Company, which has an extensive plant on both sides of Avenue D from 10th to 13th streets, East River, New York city, with wharf room for steam vessels, reports a great deal of business. The company is building a power plant on 11th street which will be 35 by 60 feet, to run the entire works west of Avenue D by electricity and compressed air. The Quintard Iron Works Company is also erecting a fireproof office building, 37½ feet front and 50 feet deep, three stories and basement, on the site of the old office, 742 East 12th street.

LARGE INCREASE IN BUSINESS.—The Independent Pneumatic Tool Company, First National Bank Building, Chicago, Ill., announces a large increase in its business during the months of October and November, having received a large number of orders for "Thor" pneumatic tools and appliances from all parts of the world. One cable order included two hundred "Thor" piston air drills, reversible wood-boring machines, and pneumatic chipping and riveting hammers. The business of this company is increasing with such rapidity that it is purchasing a large amount of new machinery, and building an expensive edition to its plant.

THE H. W. JOHNS-MANVILLE COMPANY, 100 William street, New York city, has opened branch offices at Los Angeles, Cal., and Seattle, Wash.

ALLEN RIVETING MACHINES.—John F. Allen, 370 Gerard avenue, New York city, reports a large demand for his riveting machines, which, he says, many of the largest concerns throughout the country are using.

CHICAGO PNEUMATIC TOOL COMPANY.—President J. W. Duntley, of the Chicago Pneumatic Tool Company, Chicago, Ill., has issued a statement of the earnings of the company for the third quarter of the present year. This statement shows that the profits for the quarter were nearly $250,000, and that after paying dividends and making allowances for depreciation, etc., the company gave to surplus over $100,000, showing that the company is in excellent condition, having a total surplus of nearly half a million dollars.

THE BRASS FLANGED HUB VALVES manufactured by the Lunkenheimer Company, Cincinnati, Ohio, are used, so say the manufacturers, by the thousand in the navy and in the merchant marine. The Lunkenheimer Company makes engineering specialties of every description.

THE BIRD-ARCHER COMPANY, 209 Washington street, New York city, has appointed E. E. Caine, Seattle, Wash., its agent for the states of Oregon and Washington. Mr. Caine is well-known on the coast in the shipping circles. The Bird-Archer Company is shortly to erect in San Francisco a factory in which it will manufacture its marine and stationary boiler compounds. The company is doing this in order to be in closer touch with its rapidly-growing Oriental trade.

THE ELATERITE PAINT AND MANUFACTURING COMPANY, Des Moines, Ia., has received the following letter from Con McCauley, Master of the S. S. *Atlanta* of the Goodrich Transportation Company, Chicago, Ill.: "Beg to say we have used the paint bought of you, and are well pleased with it, as it does not blister and makes a good appearance, and am glad to recommend it as being an excellent paint for boat use."

AIR POWER PLANTS for shipyard and foundry are manufactured by the Ingersoll-Rand Company, 11 Broadway, New York city. The company states that as government specifications call for the highest refinement of design and efficiency, that the fact that the United States government in its six principal navy yards uses 21 Ingersoll-Rand compressors of various types and capacities is proof of the superiority of the company's machines.

SMITH & ROBINSON, ENGINEERS, Provident Building, Philadelphia, Pa., have contracts for six large wooden spoil scows and two dump scows for the Empire Engineering Corporation, New York. These scows are for use in an extensive dredging operation on the New York barge canal. Two of the scows are completed and will be delivered before the first of December, the others will be delivered in the early spring so soon as the weather permits. This firm also is in communication with parties regarding the sale of several tug-boats, launches, etc., on a brokerage basis, and has been busy with consulting and admiralty work both in Philadelphia and New York. Those wishing to buy or sell steamers, tugs or barges of any kind can receive full information by communicating with Smith & Robinson.

CANADIAN PLANT FOR PRATT & WHITNEY COMPANY.—It is announced that the Pratt & Whitney Company has purchased a plant in Dundas, Ontario, for the manufacture of a full line of small tools—taps, reamers, milling cutters, punches, dies, etc. The building is a modern structure and the power plant is already in place. The machinery equipment is being made ready at Hartford, and will be sent there and operations begun immediately. The plant, we are informed, will also include a department for manufacturing a full line of twist drills, an elaborate equipment of special machinery having been made ready for the purpose. The location of the factory is near that of the John Bertram & Sons Company, which, as has been announced, was recently purchased by the Niles-Bement-Pond Company.

ENGINES FOR MARINE AUXILIARIES are advertised by the Boston Steam Engine Company, 246 Summer street, Boston, Mass. The company states that its engines are of high speed, are light and easily overhauled, combining the advantages of lightness and accessibility of the open type with the neatness and freedom from dirt of the heavy cast iron engine. The company's designing engineer has had many years' experience with marine engines. The entire enclosing of all of the working parts, valve gears, as well as reciprocating parts in a double casing of sheet iron, the company states is a great advantage. There is a minimum number of working parts which might under any conditions work lose while all adjustments of bearings are easily reached. The company states that its engine at 100 pounds of steam runs electric generators ranging from 1 to 25 K. W. in capacity.

GOLD MEDAL FOR "LONG-ARM" EXHIBIT.—It is announced from London that the "Long-Arm" System Company, of Cleveland, O., has been awarded a gold medal for its Earl's Court exhibit of "Long-Arm" electrically-operated power doors for ships. This was one of the few displays of American devices in the Naval, Shipping, and Fisheries exhibit. The exhibit of this system, by which bulkhead doors are closed from a central station in time of an emergency, has attracted the favorable attention of many European naval experts. Foreign admiralties are investigating it with a view to its adoption, following the example of the American Navy, which has installed the "Long-Arm" system on thirty-two of our ships. The development of automatic bulkhead doors has been effected wholly within the United States Navy. Francis T. Bowles, formerly chief constructor, first conceived the idea of an electrical apparatus for operating these doors. Another graduate of the Naval Academy, W. B. Cowles, perfected Admiral Bowles' idea into the practical system now in use.

A MEETING OF THE EXECUTIVE COMMITTEE OF THE NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS was held recently at its office, 314 Madison avenue, New York city. Among the many reports submitted by various committees was one from the committee having in charge the recent national motor-boat carnival. Upon receiving the report the following resolution was unanimously adopted: "The national motor-boat carnival recently held on the Hudson River was a grand success and the representation of boats taking part very gratifying, bringing together many types of racing boats from all parts of this country. A vote of thanks is extended to the race committee, composed of Messrs. Charles P. Tower (Larchmont Yacht Club), Anson B. Cole, (Manhasset Bay Yacht Club), A. Whitman (Seawanhaka Yacht Club), and F. W. Belknap (New York Yacht Club), for the able manner in which they conducted the numerous events; also a vote of thanks to the committee in charge of the event for the success of this great event."

A satisfactory marine-boiler compound.—The Bird-Archer Company, 209 Washington street, New York city, has received the following letter from the Dominion Atlantic Railway Company, Boston, Mass.: "I have been using your boiler compound on the ships of the company's fleet since January, with the best results. I can highly recommend your compound as a preventative of scale and grease in boilers. My experience has been on opening up the boilers of the various ships after a three months' test, that they were free from scale and grease and remarkably clean. Yours truly, A. MacGregor, Marine Superintendent."

Crandall packing.—The Crandall Packing Company, of Palmyra, N. Y., for some time has been considering the question of opening an Ohio office. The increasing demands of the trade have at last forced the establishment of a branch at Cleveland. A store has been secured at No. 9 South Water street, and has been stocked with one of the largest and most complete stocks of packing to be found in the city, and it will be in charge of Mr. John M. Chapman, who for many years has been connected with the packing business in Cleveland. Mr. Chapman will be glad to meet all his friends at his new location, and his many years of experience in this line bespeaks a successful outcome of this new undertaking of the Crandall people. Mr. Chapman expects to make this branch office the headquarters for the engineers in his territory, and the combination of a good man and a good packing should prove a winner.

"A distinct advance in piston valves," is the claim made by the Stayman Manufacturing Company, 143 Liberty street, New York city. These valves are self-expanding, the inner spring ring allowing the expansion and contraction of the interlocking segments so that they automatically adapt themselves to variations in temperature and unevenness in the valve chest. This interlocking self-expansion is said to make the piston steam tight. The company states that there are never any complaints that it needs regulating, and that it is never out of order. It is frictionless and the valve can be pulled back and forth by hand. The wear of any valve seat with a variable travel gear is increased at the ports or at the center of travel at the valves, thus producing leakage. The Stayman valve overcomes this by the expansion and contraction of the head to suit the varying diameters of the valve chest, thus filling the valve space and making a steam-tight joint at all points of the valve travel.

An adjustable compass-deviation corrector and position finder.—The Arbecam Alidade, adjustable compass-deviation corrector and position finder, made by Benjamin Varnum How, Boston, Mass., is especially designed for instantly taking bearings, cross bearings, etc., directly from the compass without possibility of error. It is said to be unaffected by vibration, rolling or pitching, and to adjust itself to every motion of the vessel. For commanding officers and navigators this instrument is invaluable, so the manufacturer states, as it simplifies many of the navigation operations and conduces to accuracy in a remarkable degree. With it the navigator takes no chances of error in the application of the deviation to compass courses or bearings. It is easily attached to any binnacle and ready for instant use day or night. The catalogue issued by Mr. How, a free copy of which will be sent upon application, states that the instrument has been tested by scores of careful practical navigators as well as teachers of navigation, all of whom give their unqualified endorsement. United States hydrographic officers testify as to its great merits. It is used in the revenue cutter service, twenty-one being ordered at one time for its vessels. A number of large yachts are also provided with this instrument.

HELP AND SITUATION ADVERTISEMENTS.

Advertisements will be inserted under this heading at the rate of 4 cents per word. No advertisement will be inserted for less than 75 cents for the first insertion, and for each subsequent consecutive insertion the charge will be 1 cent per word. Cash must accompany the order. Replies can be sent to our care if desired, and they will be forwarded without additional charge.

Who Wants an Experienced New York Representative? A man 40 years old, married, college graduate, 17 years' experience in shipbuilding as designer, in charge of construction, and engineer representative, having extended business acquaintance, desires position as sales representative in New York city of established firm connected with shipbuilding. Address EXPERIENCED, care MARINE ENGINEERING, 17 Battery Place, New York.

A manufacturing corporation making specialties applicable to most engineering and industrial lines desires to secure the services of men having technical training in the engineering line and some experience as salesmen; one to be located in New York city and one in Chicago. Address T. B., care MARINE ENGINEERING, 17 Battery Place, New York.

ENLARGED LAUNCH WORKS.—Palmer Brothers, Cos Cob, Conn., have been obliged again to greatly enlarge their facilities for building engines and launches. It will be recalled that this firm built a large plant only a year or two ago, and now an expensive addition has ben made so as to be prepared to fill orders promptly for the coming season.

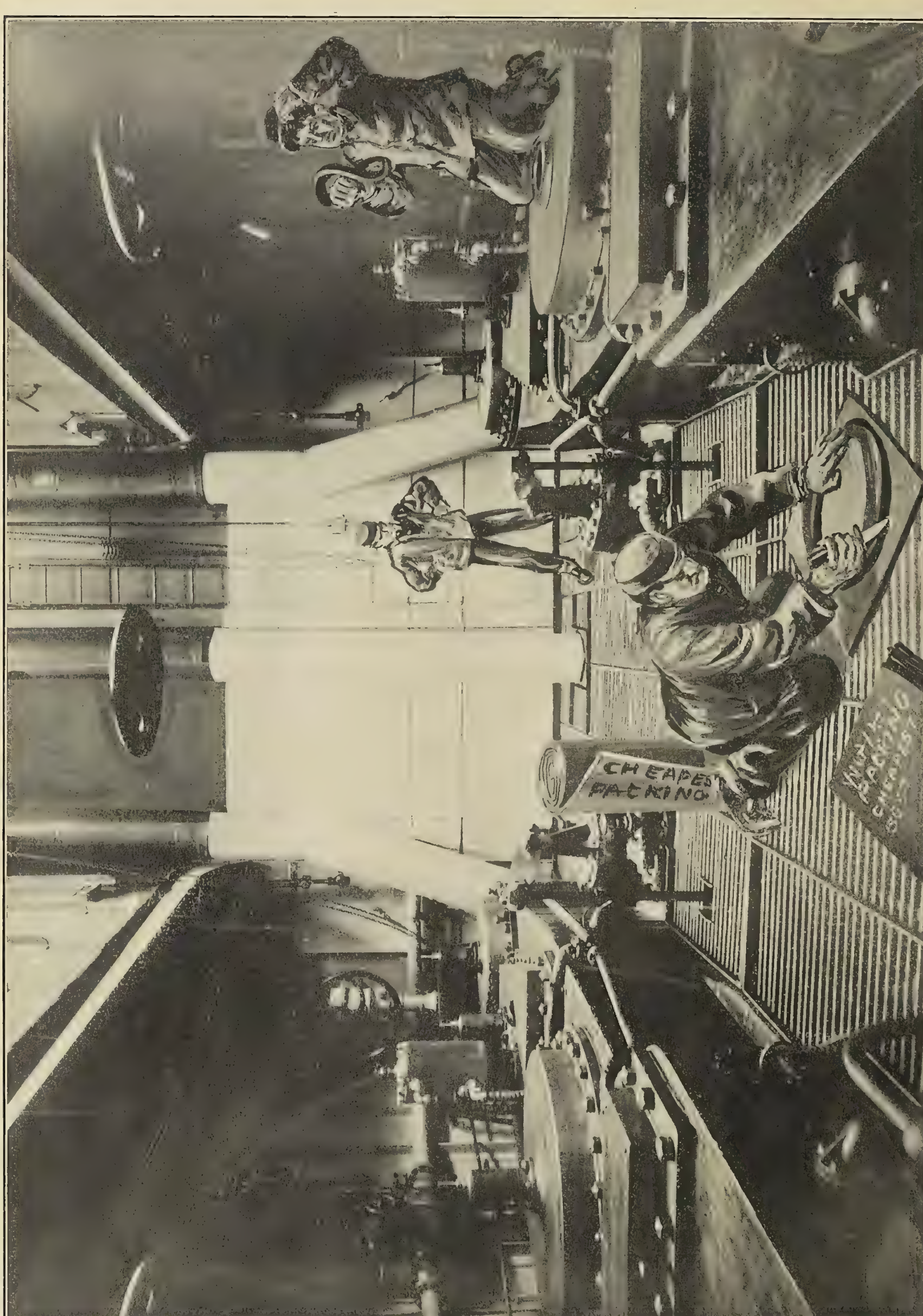
AMERICAN ROOFING TIN IN CHINA.—England has heretofore practically controlled the sale of terne or roofing plates to other countries than the United States, but a notable instance of American progressiveness is reported by Merchant & Evans Company, successor to Merchant & Company, Inc., the well-known manufacturers of high-grade roofing plates, metal Spanish tiles, "Star" ventilators, etc., in Philadelphia, Pa. This company reports that its Chicago office has completed shipments, amounting to thirty thousand square feet, of "Merchant's Old Method" roofing tin for the American legation buildings, at Pekin, China.

Beginning with the issue of January

MARINE ENGINEERING

will be published simultaneously in London and New York

ANY **instructions regarding advertisements** in the American Edition must be in the New York office not later than the tenth of the month ***preceding*** publication; and for the English edition, in the London office not later than the twentieth of the month, to insure the carrying out of such instructions in the issue of the month following.



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ECLIPSE SECTIONAL RAINBOW GASKETS.